GLOBE Research and Inquiry Learning Activities

Primary

Learning Activity 1 – What Do You Do With a Data Point?

Task 1 – Organizing Data
This beginning activity concentrates on students manipulating and organizing data. Temperature values are written on cards so that young students can easily reorder the cards to find the highest and lowest values.

Task 2 – Grouping Data
Students then discover how to organize data into groups by experimenting with water of different temperatures.

Learning Activity 2 – Graphing Your Data

Task – Make a Graph
Students create and interpret a graph of their data to explore trends and to learn how to estimate future data from a trend.

Learning Activity 3 – Comparing Two or More Data Sets

Task 1 – Compare Your Temperatures
Students learn to graph and compare two data sets and explore the range, trends and differences between two data sets.

Task 2 – World Comparisons
Each month students are introduced to four or more other GLOBE countries around the world and can compare their data.

Learning Activity 4 – Where is the Coolest Place?

Task – Map the Temperature
This activity introduces students to methods of visualizing spatial data in a very simple format. This section also emphasizes the cooperative aspects of science as each student or student group contributes data to a greater data set.

Middle

Learning Activity 1 – Dancing with Data

Task 1 – Observe
Students make observations from GLOBE graphs.

Task 2 – Question
Students evaluate research questions that are presented then create their own questions from their observations.

Task 3 – Hypothesize
Students evaluate hypotheses that are presented then create their own hypotheses from their research questions.

Learning Activity 2 – Which is the Rainiest Place?

Task – Find the Rainiest Place
Students use percentage to compare data sets

Learning Activity 3 – Mean, Median, Mode

Task 1 – A Class Representative
Students choose a person to represent the height of their class.

Task 2 – Representative Numbers
Students explore mean, median and mode using GLOBE data

Learning Activity 4 – Standard Deviation

Task 1 – Reading the Rain Gauge
Students use standard deviation to determine how high a step stool to buy to read their rain gauge.

Task 2 – Classifying pH Data
Students use standard deviation to evaluate data sets

Learning Activity 5 – Analysis with Isopleth Maps

Task – Make a Map
Create and compare isopleth maps to analyze regional temperature patterns.

Learning Activity 6 – Planning an Investigation

Task – An Investigation
Using data from one school, determine if water or soil is a better buffer for heat change.

Advanced

Learning Activity 1 – I'll Try a Sample

Task – Sampling Strategies
Explore how sampling strategies will affect results.

Learning Activity 2 – Missing Data and Models

Task – Create a Model
Create a model to predict water temperature

Learning Activity 3 – More and More Data

Task – Use Modeled Data
Use GLOBE Resource Data in a research project.

Primary

LA1: What Do You Do With a Data Point?

Purpose

To introduce young students to the inquiry process and organizing data

Student Outcomes

Students will be able to organize and compare current air temperature data, interpret the meaning of the data, and make predictions about data to be collected in the future.

Overview

Students will collect current air temperature measurements. They will then organize and interpret the data in order to answer their questions.

Time

30-40 minutes per task

Level

Primary – K-1

Key Concepts

- Everybody can do science.
- Learning can be accomplished by observation and exploration.
- Accurate descriptions aid comparisons.
- Analysis requires organization.
- Objects have physical properties.
- Properties of materials change.

Skills

- *Collecting* and *recording* data
- *Counting*
- *Organizing* data
- *Grouping*
- *Estimating*
- *Drawing* conclusions
- *Subtracting* (not required)

Processes

- Student inquiry
- Scientific method
- Energy cycle

Materials and Tools

Task 1

- 10 daily current air temperature measurements
- Colored pencils (red)
- *Organizing and Comparing Numbers Work Sheet*

Task 2

- *Grouping Data Work Sheet*
- 2 cups or beakers per group of 3-4 students
- Marker to label cups
- Water
- Ice
- Spoon
- Thermometer for measuring water temperature
- GLOBE Science Log
- Pencils

Preparation

Teach students the protocol for collecting daily air and soil temperatures. Note: Although GLOBE protocols have students collect minimum and maximum air temperature as well as current air temperature, we will only use the current air temperature in this activity.

Collect at least 10 days of temperature measurements.

Prerequisites

Recognizing numbers up to 50
Reading a thermometer
Counting

Preparation

Prepare students for the activities by having them collect GLOBE current daily air temperature and soil temperature data for at least 10 days. Each day as they go out to collect data, have them make an educated guess (hypothesis) as to whether the temperature will be cooler or warmer than the day before. Ask them to justify their hypothesis: Why do they think the thermometer will show it to be warmer or cooler. Encourage students to go beyond statements of 'it feels warmer or cooler' to statements about other specific things they observe like rain or people wearing coats.

Example questions to guide students in forming a hypothesis about today's temperature:

1. Are people dressed warmer or cooler than they were yesterday?
2. Is it cloudier today than yesterday? How might that affect the temperature?
3. Is it windier than yesterday? Or does the wind come from a different direction? How do you know which way the wind is blowing?
4. If the weather is cool, ask if students have observed ice in the morning, frosty windshields, or seen their breath.
5. If the weather is warm, ask if students have observed animals panting, people perspiring, windows rolled down in cars, people fanning themselves or air conditioners turned on.

Have the students compare each day's data to the previous day's to test their hypotheses. As the students become more adept at stating hypotheses, encourage them to estimate the actual temperature that will be recorded.

Notes:

1. The cards used to organize data from the Work Sheet may state the Day as a date or as the day of the week, depending on which is more comfortable for you and your students.
2. Students who have not been introduced to subtraction may find the range by counting how many numbers are between the high and low temperatures.
3. Save these cards for further activities.

Task 1 – Organizing Data

Organize current air temperature data. Find the high and low temperatures and the temperature range.

What to Do and How to Do It

1. Make a set of cards using your current air temperature data. Each card should have the day and the temperature taken for that day. Write the temperature in RED.
2. Put the cards in order from lowest temperature to highest temperature.
3. What is the highest temperature you recorded?
4. What is the lowest temperature you recorded?
5. What is the difference between the high and low temperatures? The difference between the high and low temperatures is called the *temperature range.*

Ask students, "Do you think a change in temperature of 2 degrees C from one day to the next makes a difference in how hot or cold it feels? A little difference or a big difference? How about 4 degrees? 6 degrees?"

How can we decide what it means to have a small temperature change or a big temperature change?

Organizing and Comparing Numbers

Work Sheet

Day 1 _____ *Date* _____ **Temperature**	**Day 2** _____ *Date* _____ **Temperature**	**Day 3** _____ *Date* _____ **Temperature**
Day 4 _____ *Date* _____ **Temperature**	**Day 5** _____ *Date* _____ **Temperature**	**Day 6** _____ *Date* _____ **Temperature**
Day 7 _____ *Date* _____ **Temperature**	**Day 8** _____ *Date* _____ **Temperature**	**Day 9** _____ *Date* _____ **Temperature**
Day 10 _____ *Date* _____ **Temperature**	**Day 11** _____ *Date* _____ **Temperature**	**Day 12** _____ *Date* _____ **Temperature**

Task 2 – Grouping Data
Determine classes of *small, medium,* and *big* temperature ranges

What to Do and How to Do It

1. Divide the class into lab groups of 2 to 4 students. Provide each group with two cups 1/2 full of water (labeled Cup 1 and Cup 2), a cup of ice, a spoon and a thermometer. Each student should have a *Grouping Data Work Sheet.*
2. Measure the temperature of the water in both cups by placing the thermometer in the cup for at least 1 minute. Both cups should be the same temperature. Record the temperature of the water in each cup.
3. Place an ice cube in Cup 2. Watch the thermometer until the water has cooled 2 degrees. Remove the ice with the spoon.
4. Put your fingers into both cups – one hand in each cup – and wiggle your fingers.
5. Does 2 degrees difference in temperature make a difference in how cold the water feels? Does it seem to be a big difference, medium difference, or small difference? Record the temperature of each cup and whether you think there is a big, medium or small difference.
6. Repeat Steps 3 – 5 several times, lowering the temperature in Cup 2 two degrees each time. Record the responses.
7. Have students discuss the results and determine what they would judge to be a *small* difference, a *medium* difference or a *big* difference.
8. Use the bottom table on the Work Sheet to record the high and low air temperatures you found in Task 1 and the temperature range.
9. Did the air temperature range fall into the group *small, medium* or *big* that the students developed?

Task 2

Grouping Data

Work Sheet

Temperature of Cup 1	Temperature of Cup 2 (with ice)	Temperature Difference (Cup 1 – Cup 2)	How different does it feel? Write your feeling below. S=Small M=Medium B=Big

Conclusions

I think a Small change is less than _____ degrees.

I think a Medium change is between _____ and _____ degrees.

I think a Big change is greater than _____ degrees.

Air Temperature Range for 10 Days

Highest Temperature	Lowest Temperature	Temperature Range (Highest – Lowest)	Is the difference S or M or B

Estimating

The temperature is 23 degrees C today. The TV weather person says there will be a 'big change' in the temperature tomorrow. What do you think the temperature might be tomorrow?

_____

What do you think the temperature will be if the weather person says it will be a little colder tomorrow?

_____

Primary

LA2: Graphing Your Data

Purpose

To introduce students to creating and interpreting a graph from their data

Student Outcomes

Students will be able to create and interpret a graph they create by hand from their own data.

Overview

Students will arrange their current temperature data by day, put the data on a graph, and interpret the graph.

Time

30-40 min

Level

Primary 1-2

Key Concepts

- Graphs can aid interpretation of data.
- Properties of materials change over time.
- Everyone can do science.

Skills

- *Measuring* temperature
- *Ordering* numbers
- *Making* a graph
- *Interpreting* a graph
- *Following* instructions
- *Collecting* data
- *Recording* data
- *Organizing* data

Processes

- Energy cycle
- Student inquiry

Materials and Tools

- GLOBE Science Log
- Temperature cards from Primary Learning Activity 1: *What Do You Do with a Data Point?*
- Copies of *Graphing Your Data Work Sheet*
- Pencils
- Colored pencils
- Ruler

Preparation

Gather at least 10 days of current air temperature data.

Do Learning Activity 1 or put the current air temperature data you have gathered on cards.

Prerequisites

Counting

It is useful to have done Primary Learning Activity 1 before starting this activity.

Task

Graph your data and examine the graph for a pattern

Preparation

Have students use their temperature cards from Primary Learning Activity 1 or create new cards using the Work Sheet from that activity. If students have never used a ruler to draw a straight line, they may need to practice this skill.

We have provided two graph paper Work Sheets with different 'Y' axis scales. Choose the Work Sheet that is appropriate for the range of data your students will graph. If the range of temperatures is less than 10 degrees, use *Graphing Your Data Work Sheet 1*. If the range is greater than 10 degrees, use *Graphing Your Data Work Sheet 2*.

What To Do and How to Do It

1. Put your air temperature cards in order by day, beginning with Day 1.
2. Ask students, "Has the temperature gone up, down, or jumped around over the last 10 days? Has it changed quickly or slowly? Does the temperature seem to be generally going up? Down?"

Making a Graph

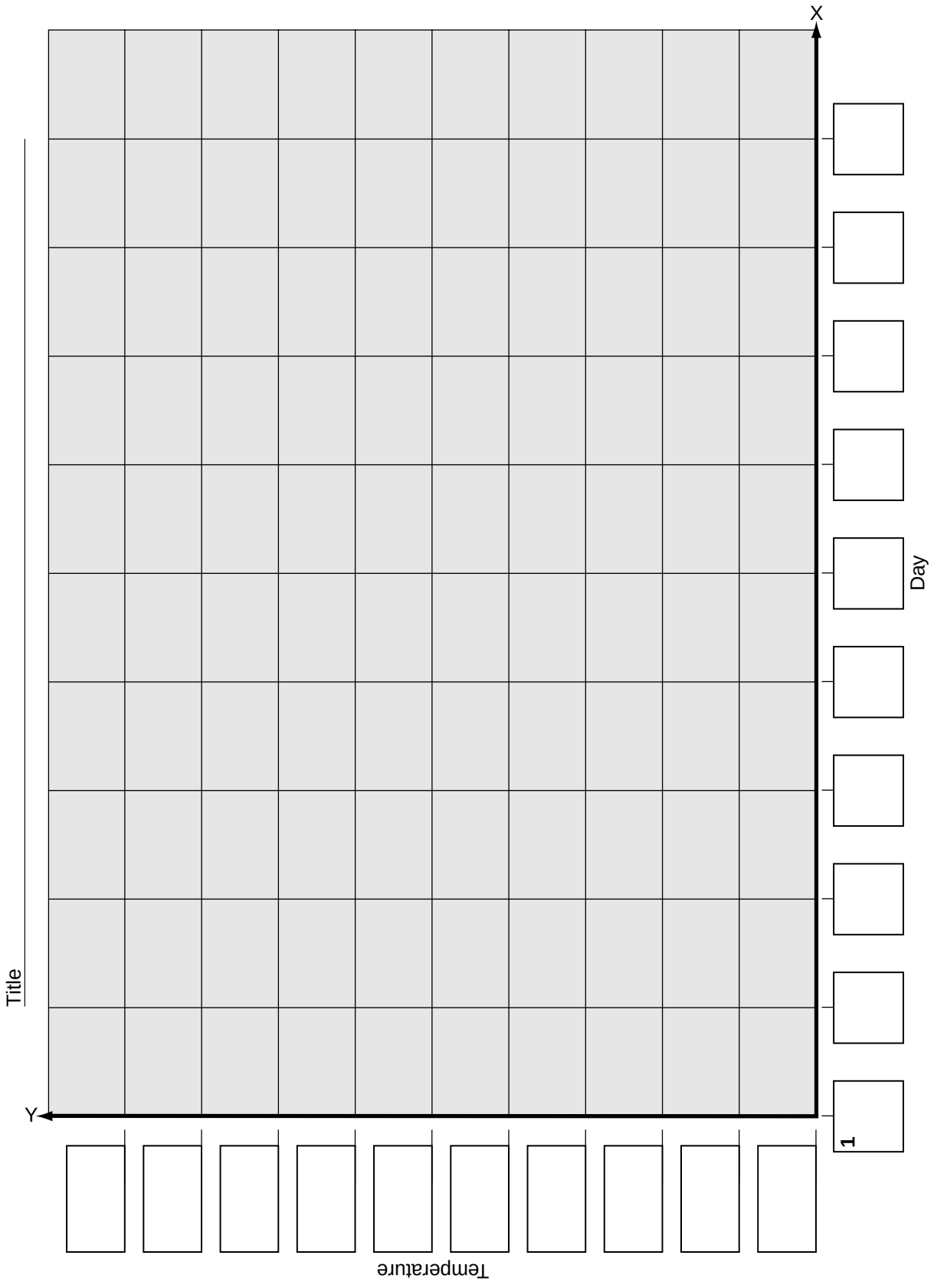
1. Count the number of days of data to graph. Number the boxes along the bottom (X axis), starting with Number 1 at the left.
2. Find the highest and lowest value of the data (see, Part 1 – *Organizing and Comparing Numbers*).
3. Write the lowest value in the bottom box of the Y-axis (the boxes going up along the side). Number the boxes going up starting at this number.
4. Plot your data. For each day, follow straight up from the day box and straight over from the correct temperature for that day. Put a RED dot where the lines meet.
5. Once all of the days are plotted, use your ruler to connect the dots from left to right with a RED line.
6. Make a title for your graph that explains what is on the graph.

Interpreting the Graph

1. Ask students, "Has the temperature gone up, down, or jumped around over the last 10 days? Does the temperature seem to be generally going up? Down?" If data seem to be going generally up or down or following a pattern we say there is a *trend* in the data. If it does not seem to be going mostly up or down, we say there is no trend in our data.
2. Ask students, "If the trend in our temperatures continues, where do you think the line will go tomorrow on your graph?" How can we check to see if your estimation is correct?

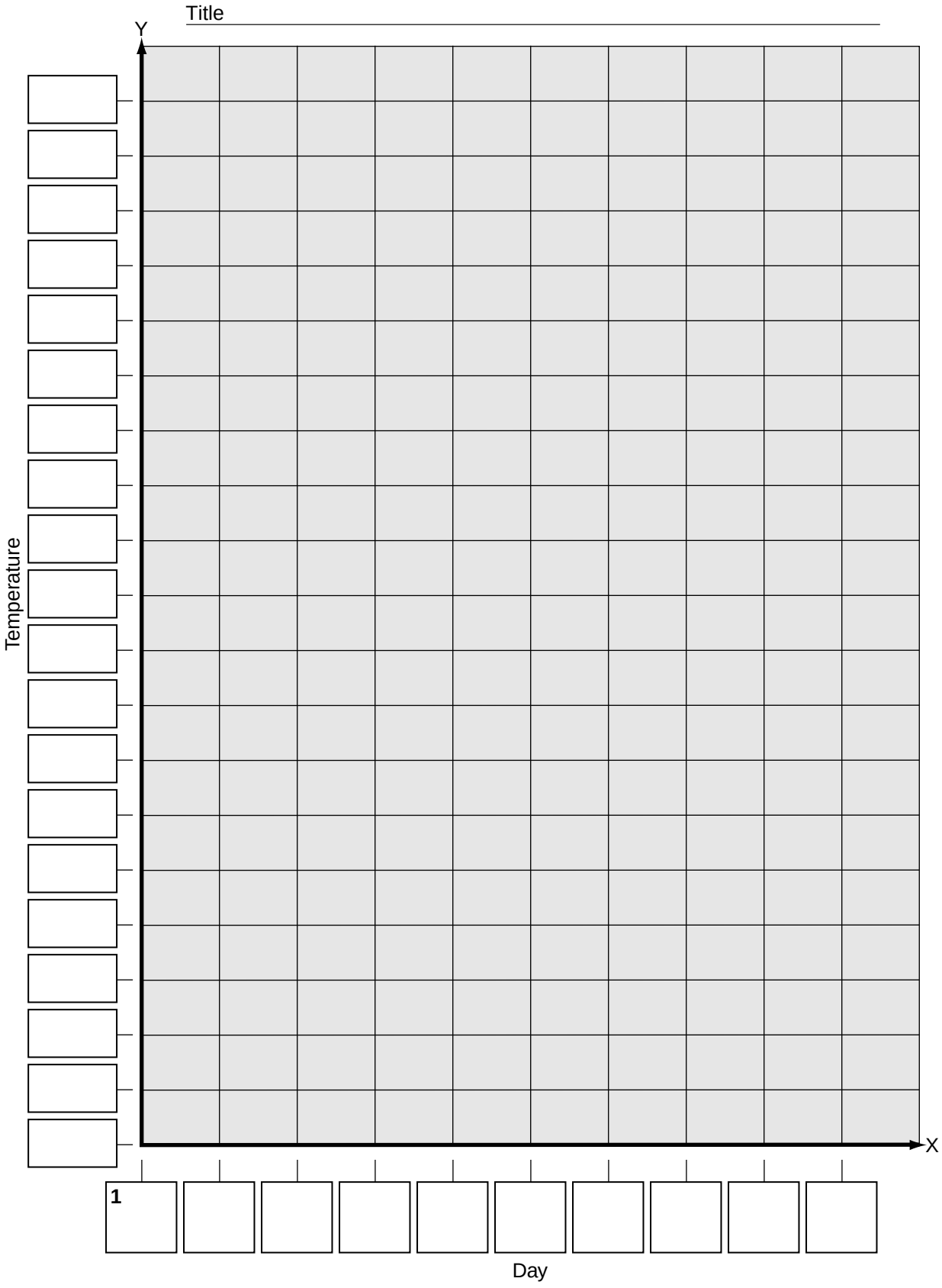
Graphing Your Data

Work Sheet 1



Graphing Your Data

Work Sheet 2



Primary

LA3: Comparing Two or More Data Sets

Purpose

To introduce students to graphing and interpreting two or more data sets on a graph

Student Outcomes

Students will be able to create and interpret a graph they create by hand from their own data sets and compare their data with data from other schools.

Overview

Students will arrange their current temperature and soil data by day, put the data on a graph, and interpret the graph. They will then compare their data with data from two to four other GLOBE countries.

Time

30-40 minutes for each Task

Level

Primary 1-3

Key Concepts

Graphs can aid interpretation of data.
Properties of materials change over time.
Different materials hold heat differently.
Data are different from place to place.
Everyone can do science.

Skills

Measuring temperature
Ordering numbers
Making a graph
Interpreting a graph
Following instructions
Collecting data
Recording data
Organizing data

Processes

Energy cycle
Spatial variation
Student inquiry

Materials and Tools

Task 1

GLOBE Science Log
Temperature cards of current air temperature from Primary Learning Activity 1- *What Do You Do with a Data Point?*
Soil temperature cards for the same days as the air temperature cards (Write the soil temperatures in BLUE using the Work Sheet from Learning Activity 1).
Copies of *Graphing Your Data Work Sheet*
Copies of *Would the temperature be different if you lived underground? Work Sheet*
Pencils
Colored pencils (red and blue)
Ruler

Task 2

One complete month of current air temperature data from your school
Copy for each student of the graph(s) provided for the same month
Colored pencils (3 colors)
World map

Preparation

Gather at least one month of current air and soil temperature data.

Do Learning Activity 1 and 2 or put the temperature data you have gathered on cards.

Prerequisites

Counting

Subtracting

It is useful to have done Primary Learning Activity 1 and 2 before doing this activity.

Task 1 – Compare Your Temperatures
Compare current air and soil temperature data

Preparation

Provide students with the Work Sheet cards for air and soil temperature and a Graph Work Sheet appropriate for the range of the combined air and soil temperature data.

What to Do and How to Do It

1. Create soil temperature cards just as you did in Primary Learning Activity 2 for air temperature. Write the soil temperatures in BLUE.
2. Use the *Would the temperature be different if you lived underground? Work Sheet* to organize and compare your air temperature and soil temperature data
3. Make a graph
   a. Count the number of days of data to graph. Number the boxes along the bottom (X axis), starting with Number 1 at the left.
   b. Find the highest and lowest value for *both* data sets. (See Primary Learning Activity 1 – *Organizing and Comparing Numbers*). You may need to mix the cards for both data sets together and order the data sets from highest temperature to lowest temperature.
   c. Write the lowest value in the lower box of the Y-axis. Number the lines going up starting at this value.
   d. Plot the air temperature. For each day, follow straight up from the day box and straight over from the correct temperature for that day. Put a RED dot where the lines meet.
   e. Plot the soil temperature. For each day, follow straight up from the day box and straight over from the correct temperature for that day. Put a BLUE dot where the lines meet.
   f. Once all of the days are plotted, use your ruler to connect the red circles from left to right with a RED line.
   g. Connect the blue circles from left to right with a BLUE line.
   h. Make a title for your graph that explains what is on the graph.
4. Interpreting the Graph
   a. Ask students, "Has the soil temperature gone up, down, or jumped around over the last 10 days? Does the temperature seem to be generally going up? Down?" Can you say there is a trend in the soil data?
   b. Are the air temperature data similar to the soil temperature data? How are they alike? How are they different?
   c. Was it easier to use the table or the graph to understand the data?

Thinking

1. Think about the three ways you have looked at your data. We have found the difference between the air temperatures and the soil temperatures. What did that tell us about the difference between the air and the soil?
2. We have compared the range of air temperature to the range of soil temperature. Which one had the greatest range? What does that tell us about the difference between the air and the soil?
3. We have compared the trend in the air and soil temperatures. What is the difference in the trend between air temperature and soil temperature? Do they both go in the same direction? Does one go up or down more quickly than the other? What does that tell us about what might happen in the air and the soil?
4. If you were an animal, would it help you stay warmer or cooler if your home was underground?

Task 2 – World Comparisons
Compare your current air temperature to other schools around the world.

Preparation

For each month of the year 2000 and for January of 2001, teachers will find two graphs of data. Each graph has data from two schools. Schools represent GLOBE countries from all over the world that had complete data sets for this time period. Provide a world map with your school identified on the map. Introduce students to other GLOBE countries by locating them on the map and comparing your temperature data to theirs. If possible, get your geography, history, language, and social studies teachers involved in finding out more about the Countries of the Month.

What to Do and How to Do It

1. Look at the graph of data for the month. If the graphs are printed in black and white, trace each line on the graph in a different color.
   a. How many schools are shown on the graph? Where are these schools?
   b. Find the approximate location of your school and the other schools on the map.
   c. Which school has the coolest temperature?
   d. Which school has the warmest temperature?
2. Use the data from your school to put a third line on the graph in a different color. (Note: if your data is outside the range of the map, you may need to add more lines above or below the existing graph.
3. How does your data compare with data from the other two schools? Which temperature record is most similar to yours? Which is most different?
4. What are some possible reasons that temperature data from other places looks different than data from your school?

Note: These graphs are also found in the *GLOBE Data Source Book* along with the data and site information for each school. Graphs from other years and other schools may be found by searching at the GLOBE Web site visualizations pages.

Would the Temperature be Different if You Lived Underground?

Work Sheet

1. Put the soil temperature cards in order from highest to lowest temperature. Put the air temperature cards in order from highest to lowest beneath them. How does the soil temperature range compare to the air temperature range?

Soil Temperature Range

Highest Temperature	Lowest Temperature	Temperature Range (Highest – Lowest)	Is the difference S=Small or M=Medium or B=Big
Soil	Soil	Soil	Soil
Air	Air	Air	Air

2. Put the soil temperature cards in order by day. Put the air temperature cards in order by day below the soil temperature cards. Copy the information from the cards onto the Table below. Copy the air temperatures in RED and the soil temperatures in BLUE.

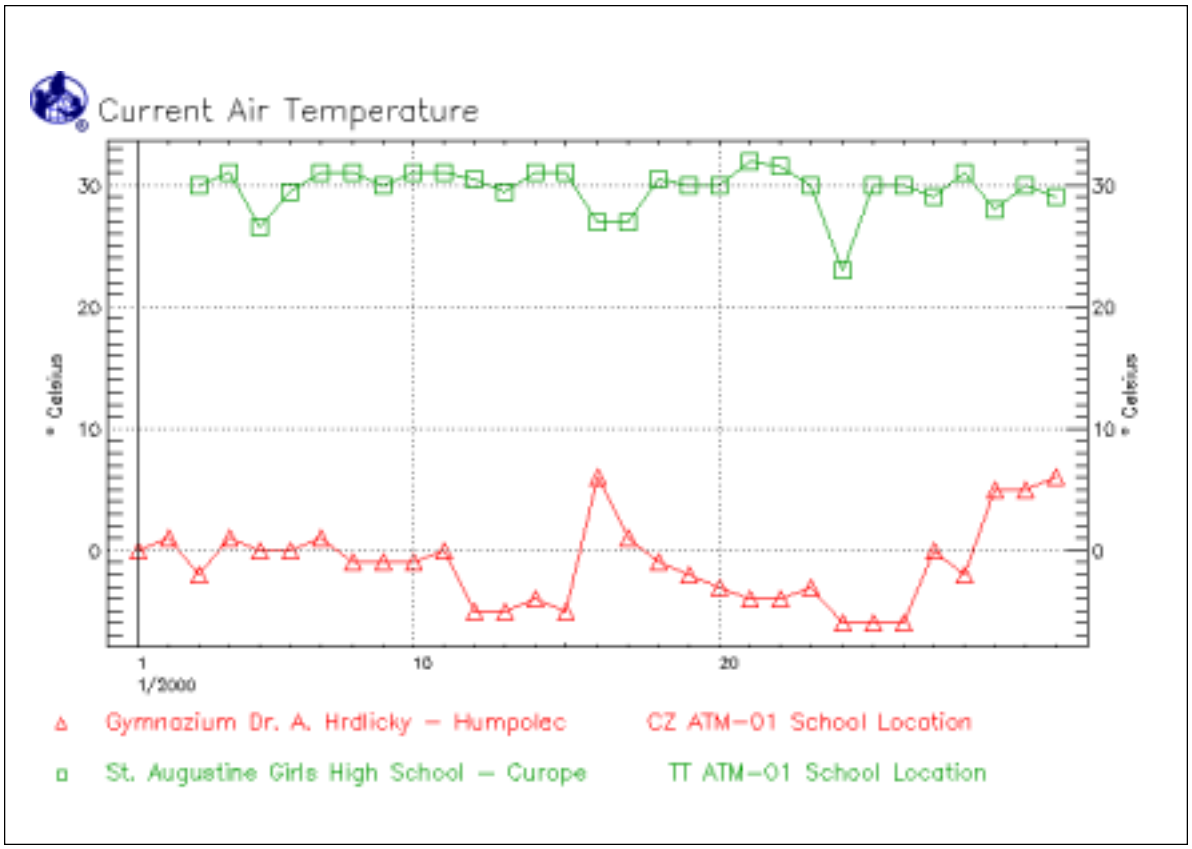
3. Look at the column for Day 1. Which is higher, air temperature or soil temperature? Subtract the smaller number from the larger number. Write the difference in the Table.

4. Fill in the difference for the other days.

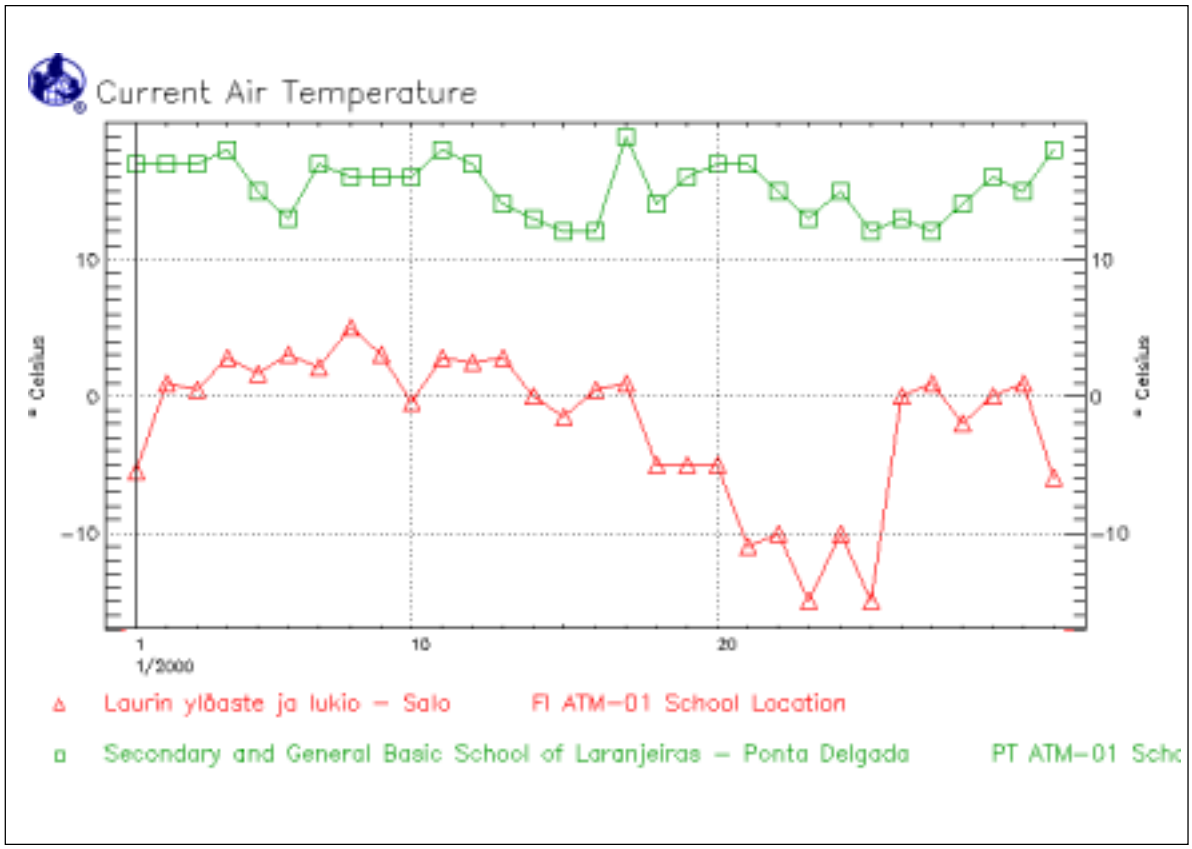
5. Decide whether the temperature difference is small, medium, or big. (See Primary Learning Activity 1). In the last row put a S, M, or B.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Air Temperature (red)										
Soil Temperature (blue)										
Temperature Difference										
S = Small M = Medium B = Big										

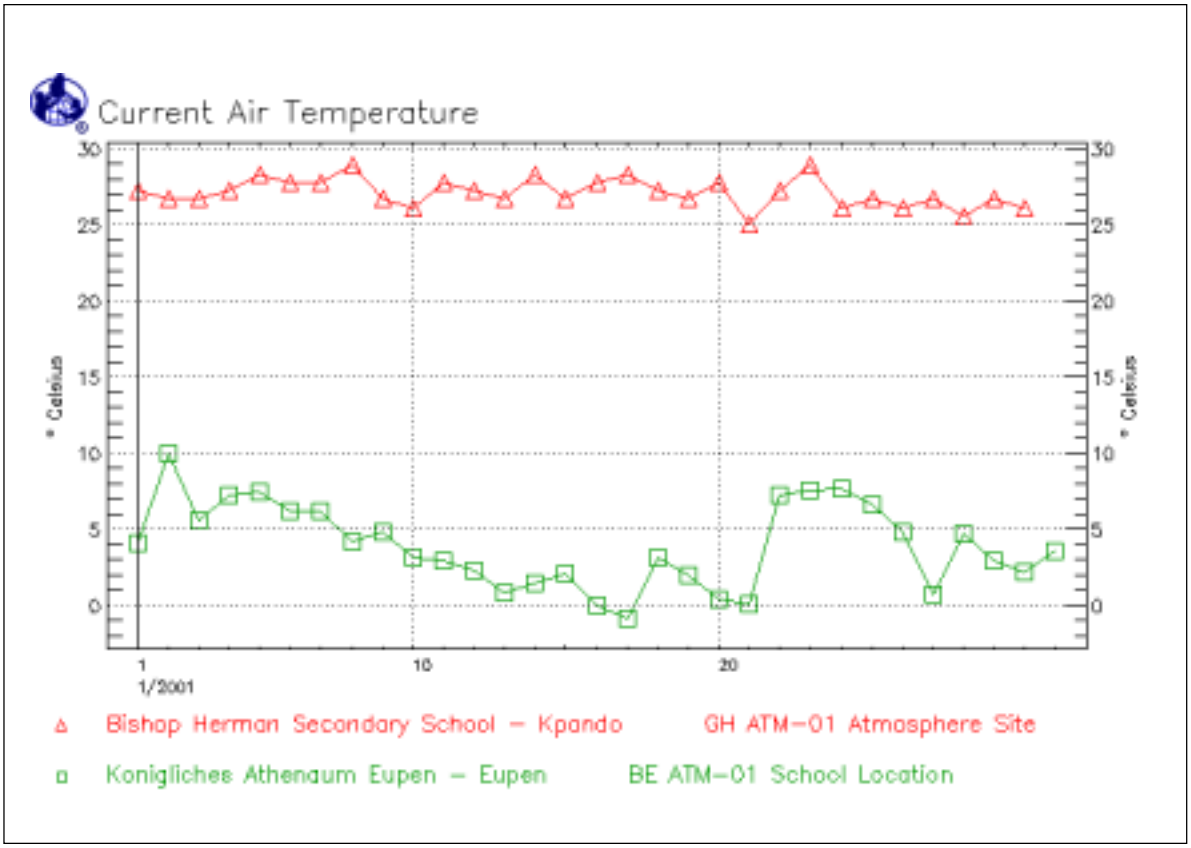
January 2000 Graphs – Czech Republic and Trinidad and Tobago



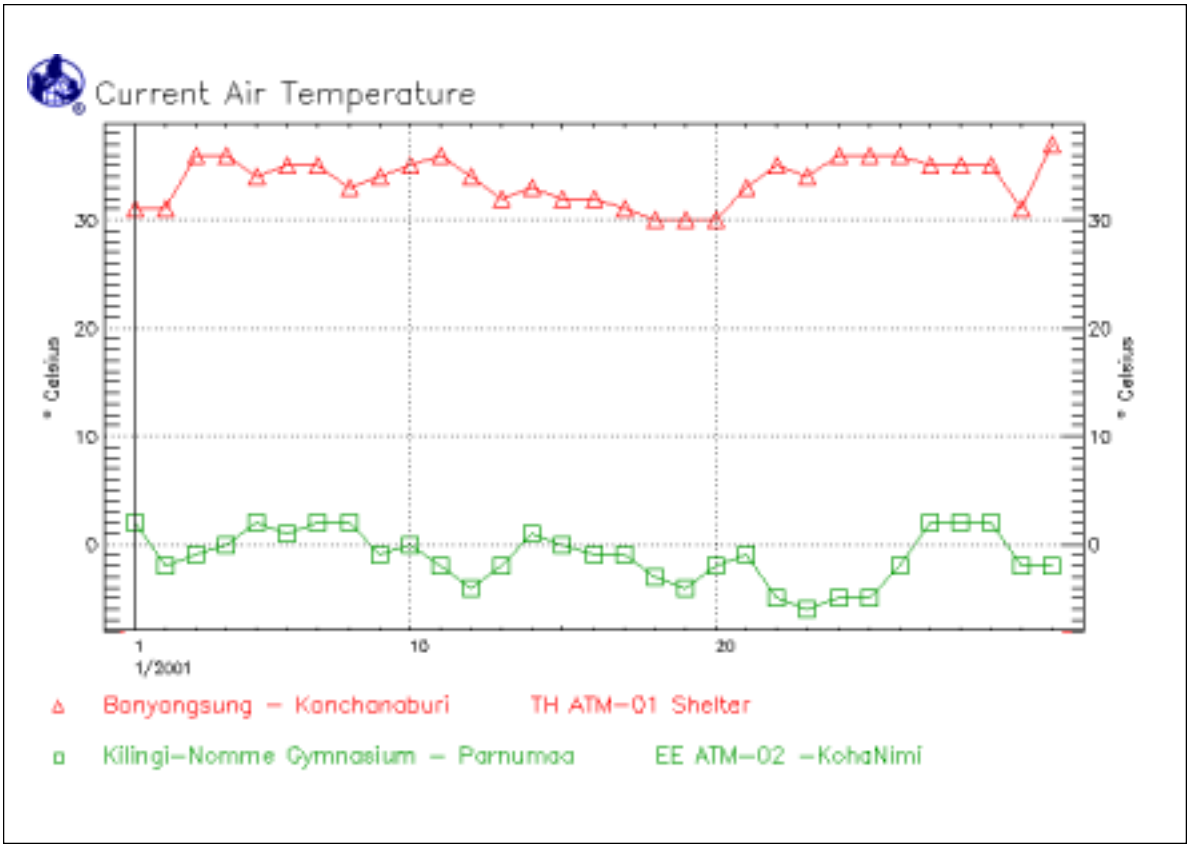
January 2000 Graphs – Finland and Portugal



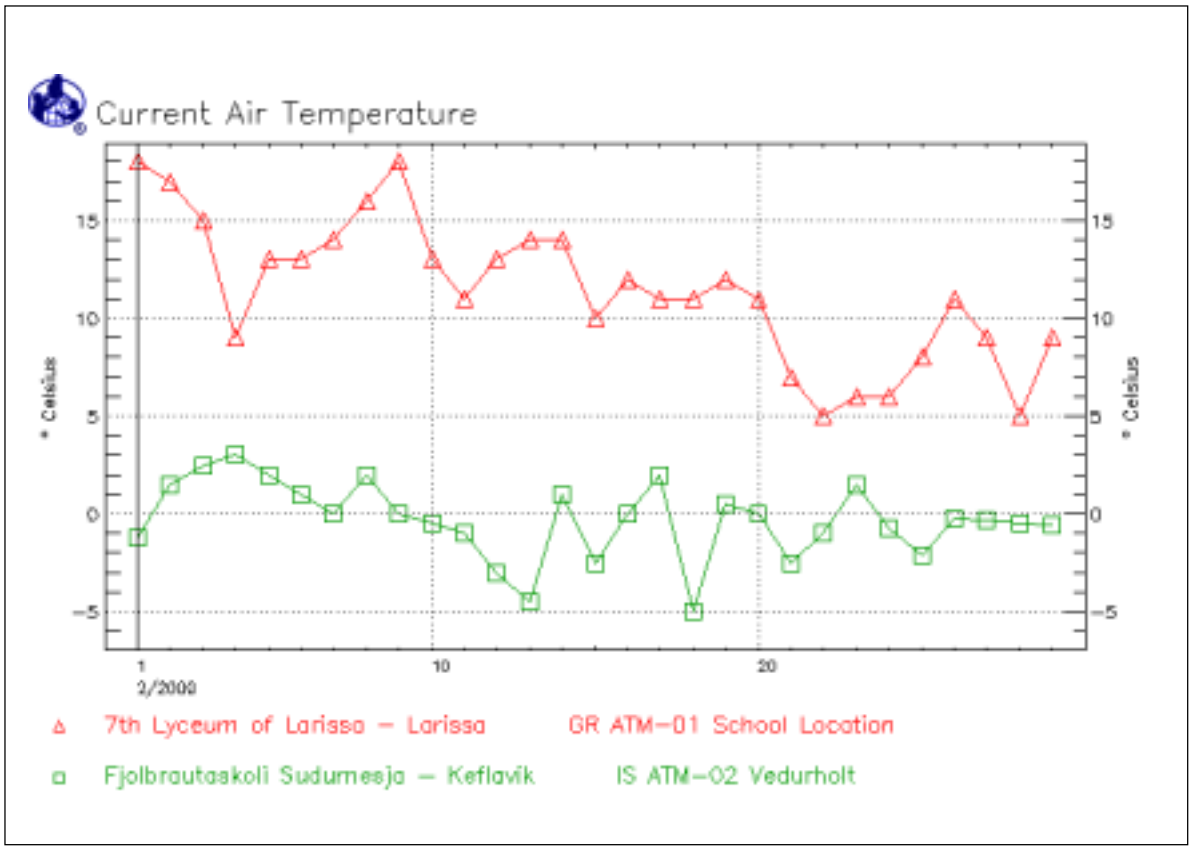
January 2001 Graphs – Belgium



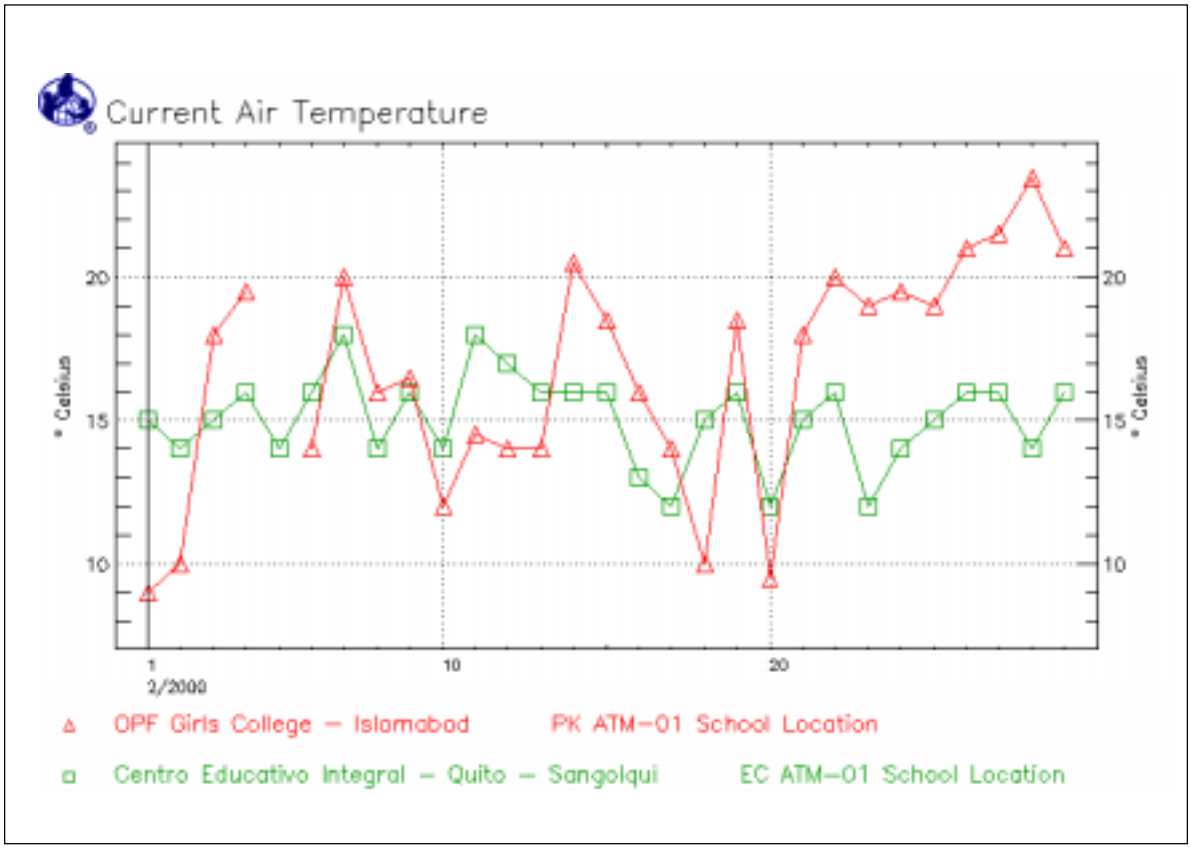
January 2001 Graphs – Thailand and Estonia



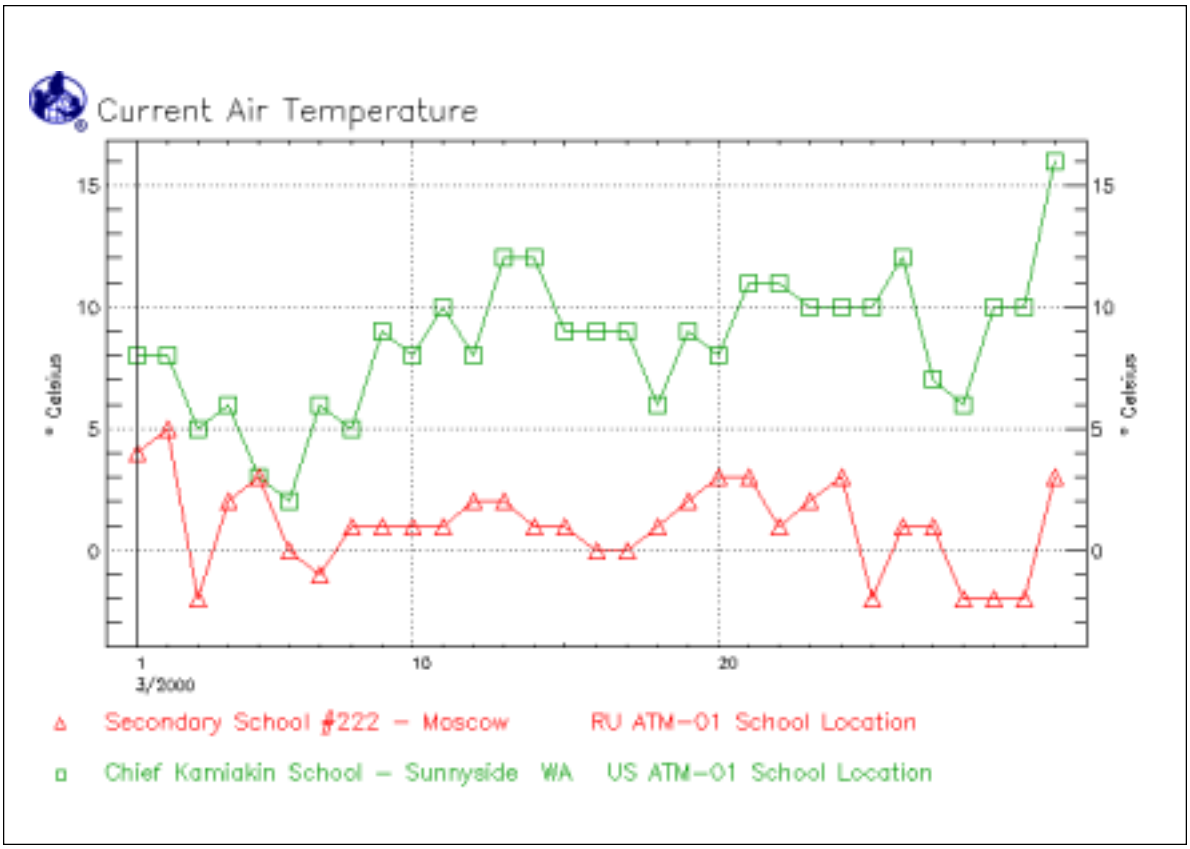
February 2000 Graphs – Greece and Iceland



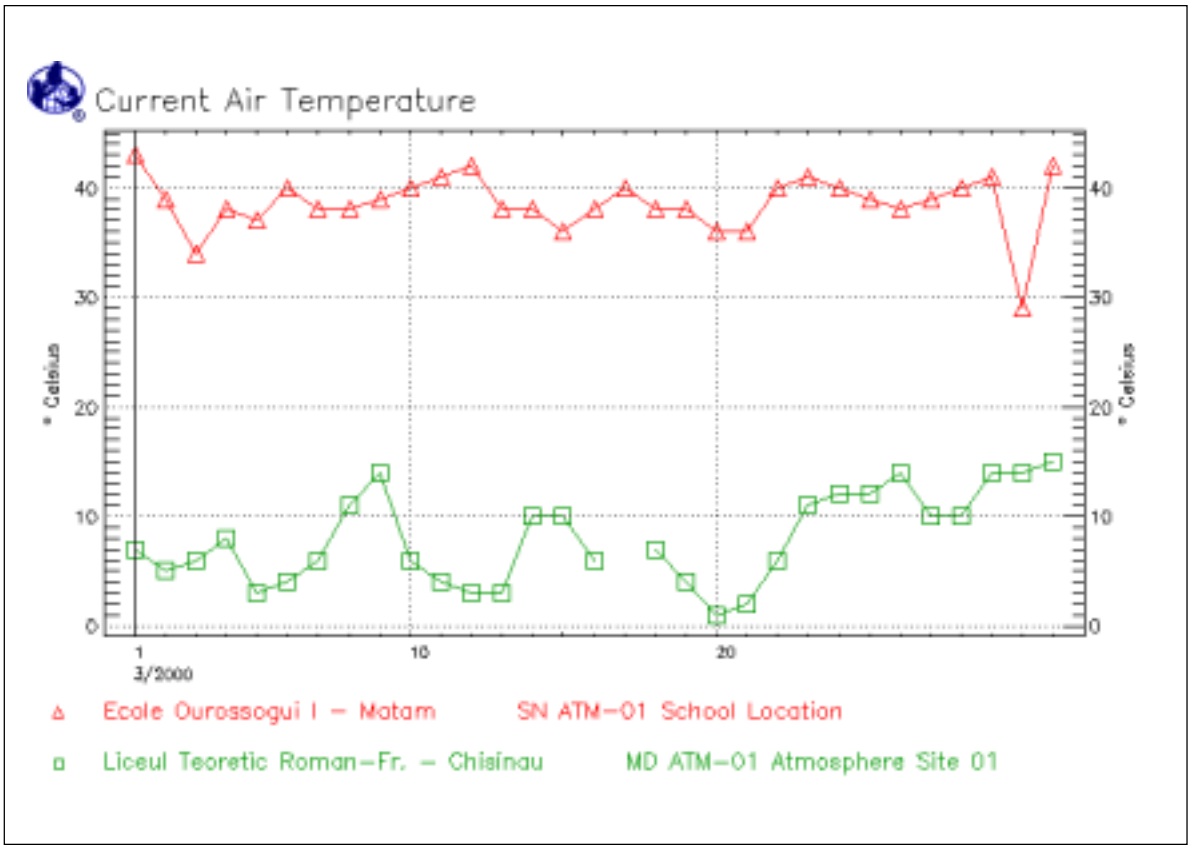
February 2000 Graphs – Pakistan and Ecuador



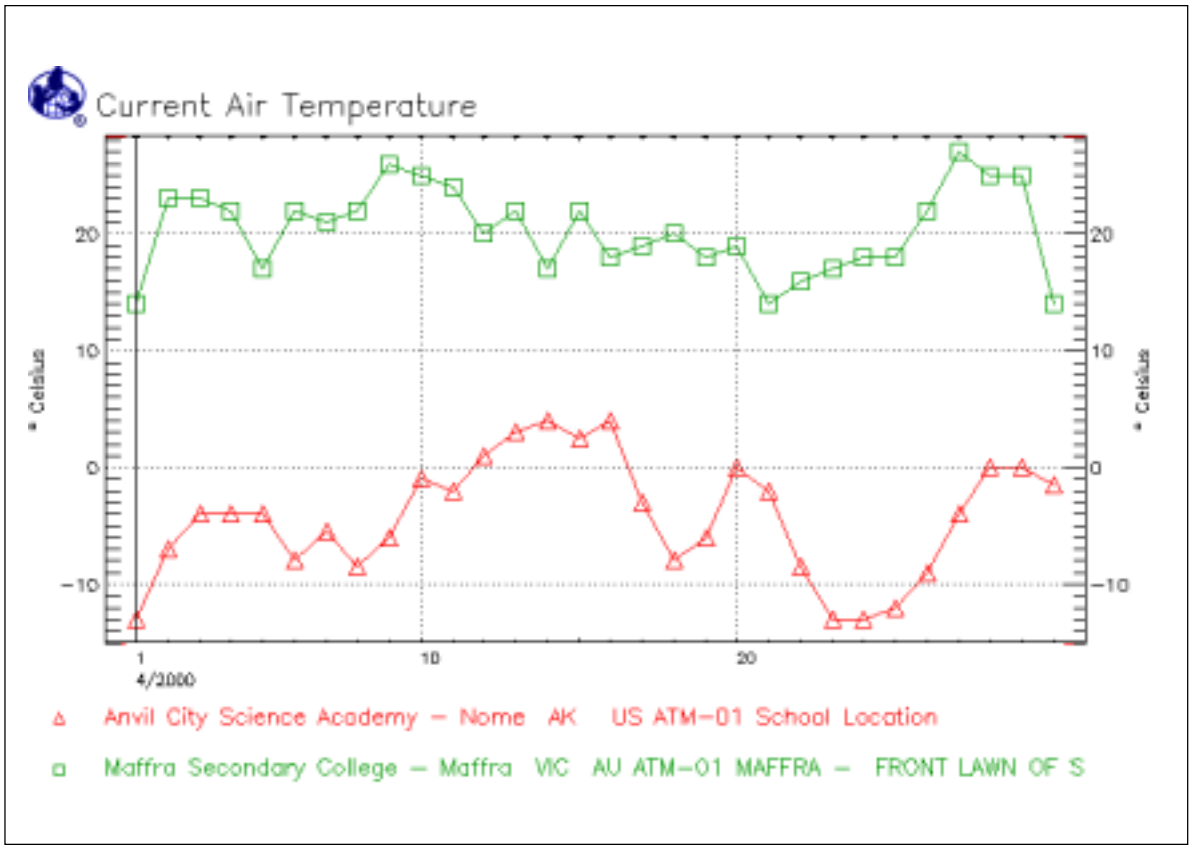
March 2000 Graphs – Russia and Washington, USA



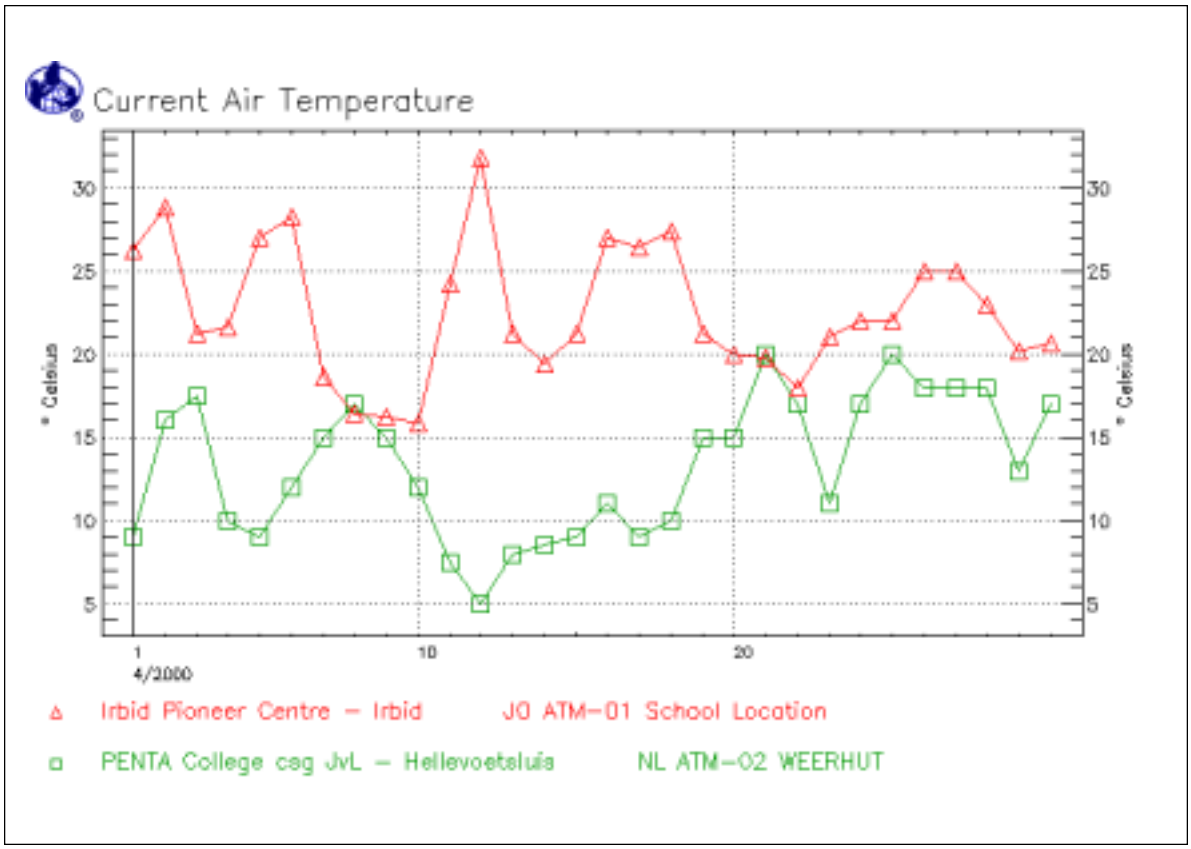
March 2000 Graphs – Senegal and Moldova



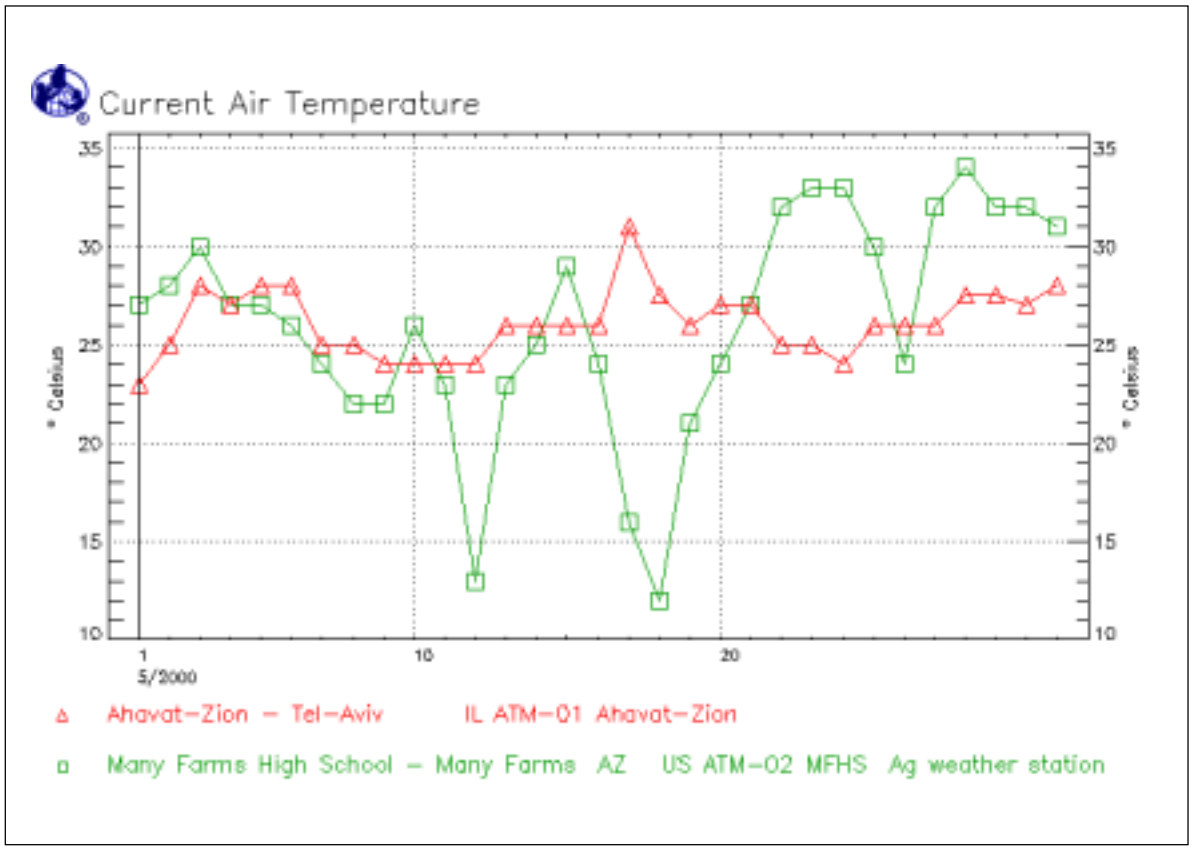
April 2000 Graphs – Alaska, USA and Victoria, Australia



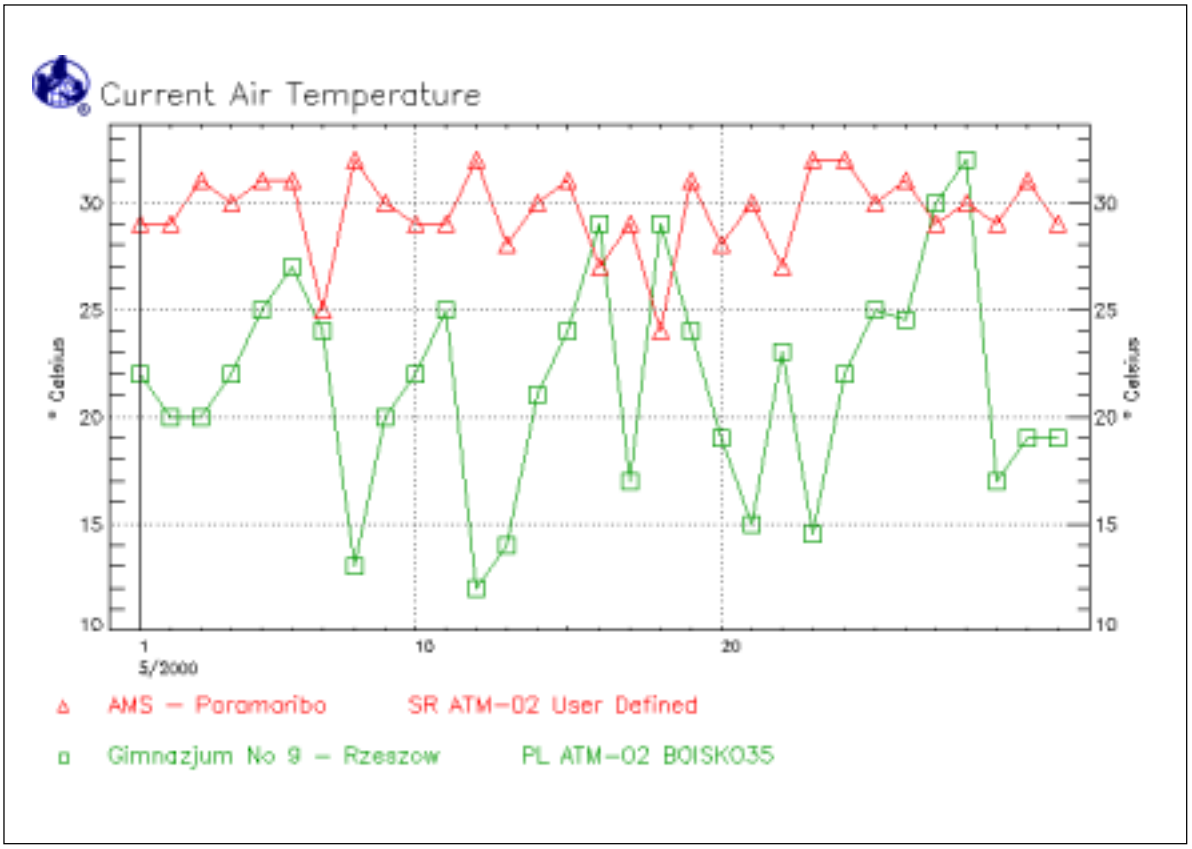
April 2000 Graphs – Jordan and The Netherlands



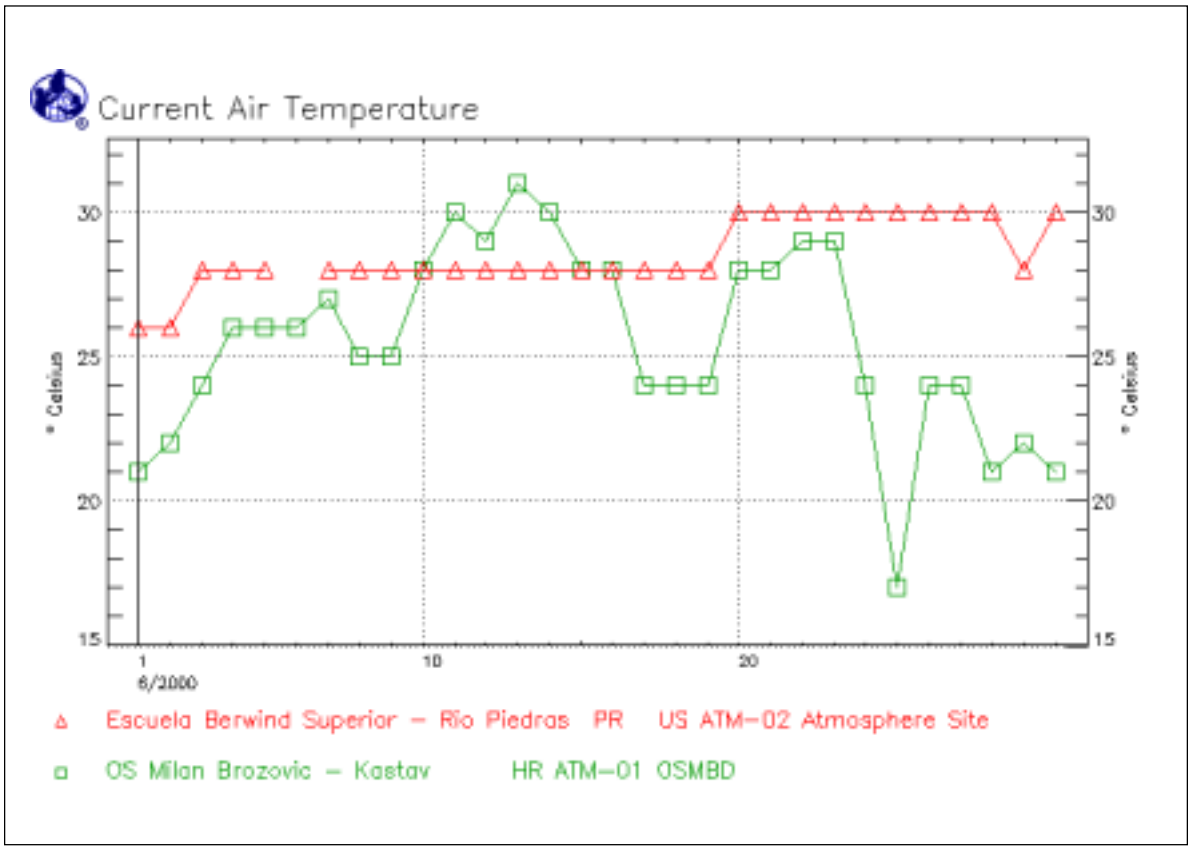
May 2000 Graphs – Israel and Arizona, USA



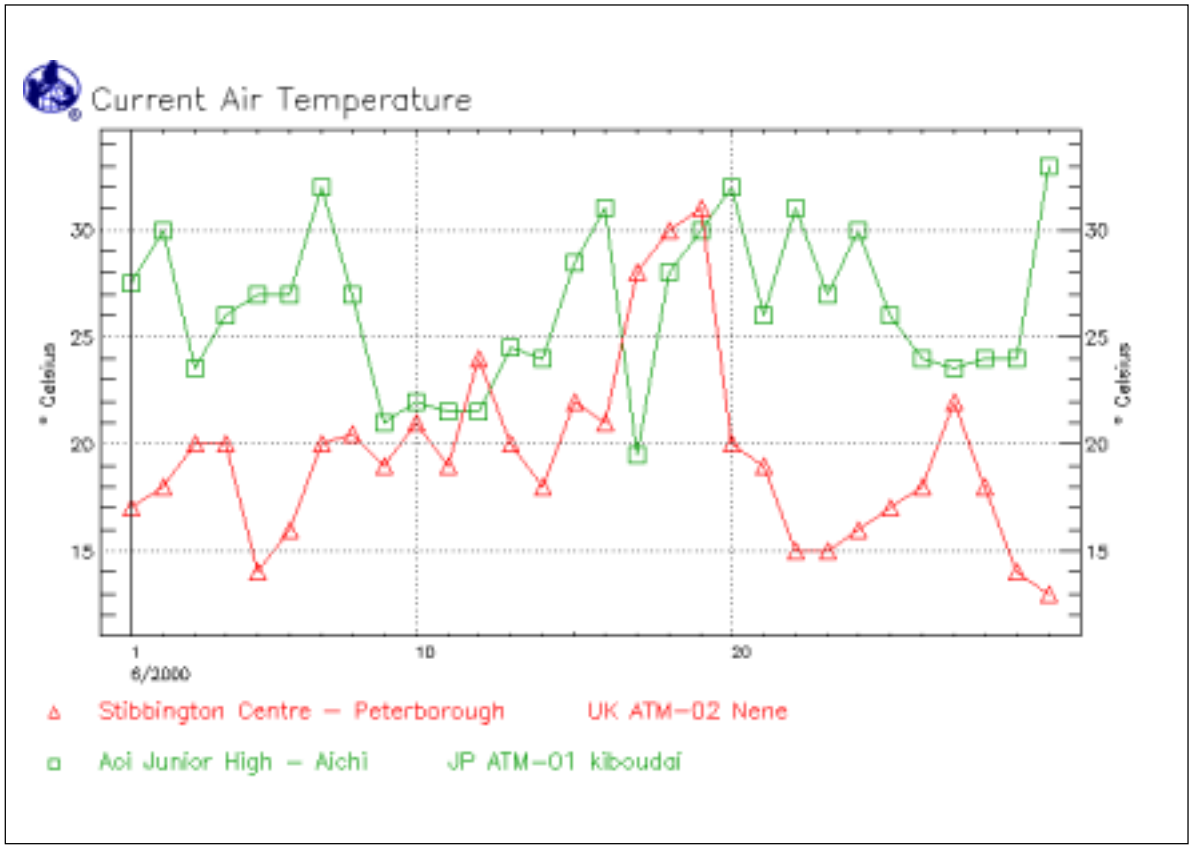
May 2000 Graphs – Suriname and Poland



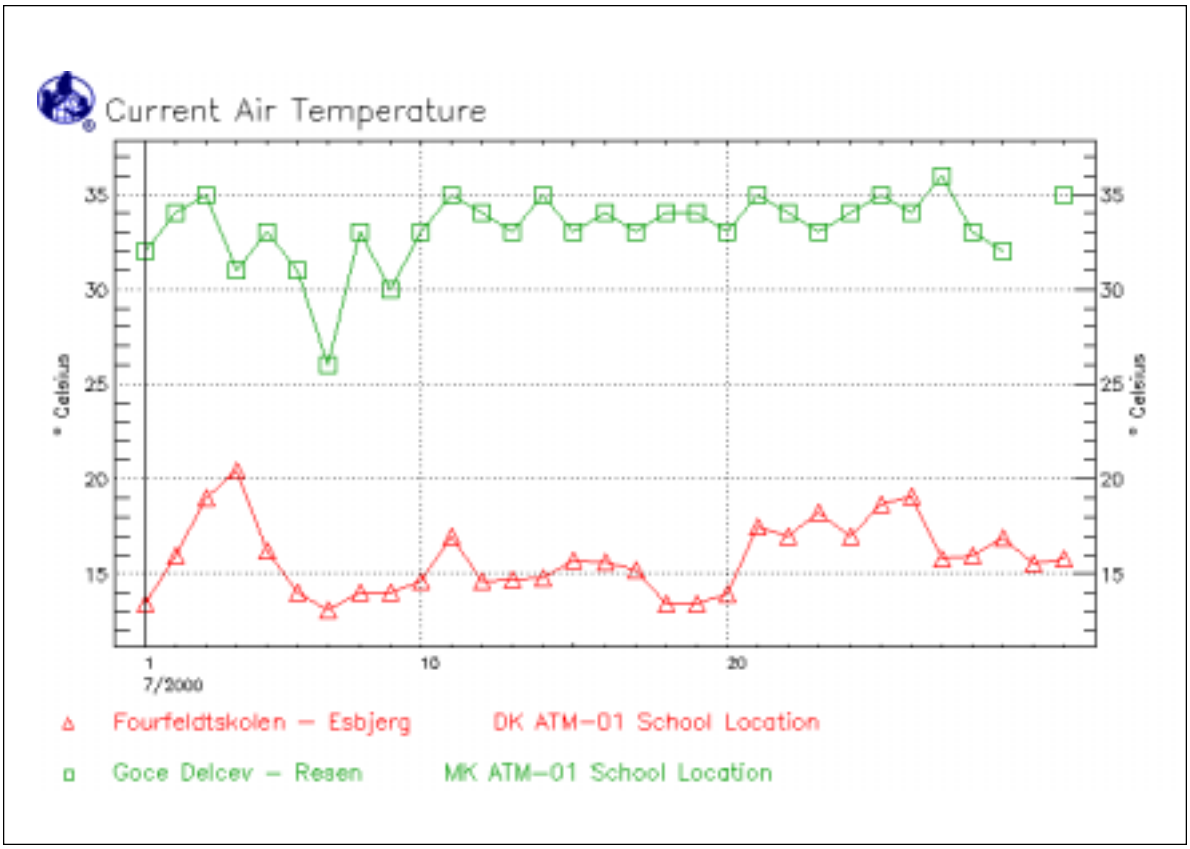
June 2000 Graphs – Puerto Rico and Croatia



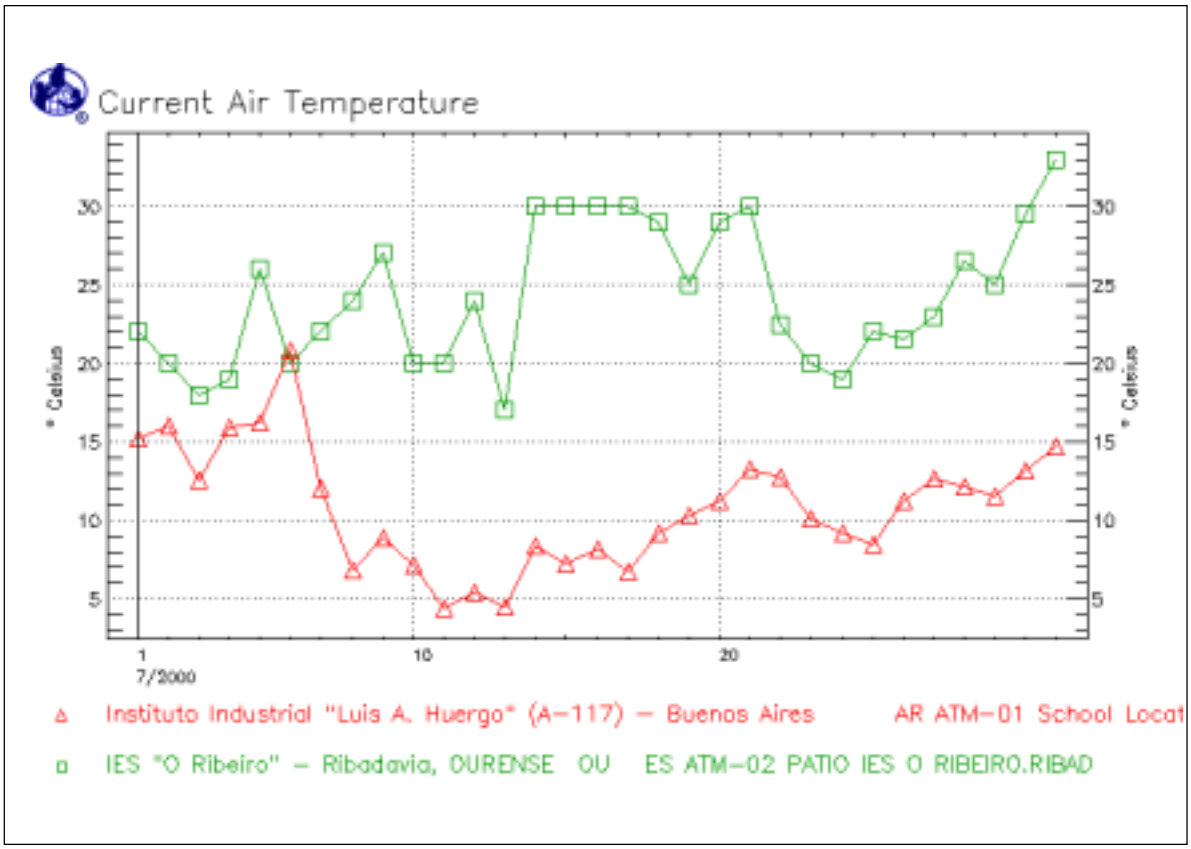
June 2000 Graphs – United Kingdom and Japan



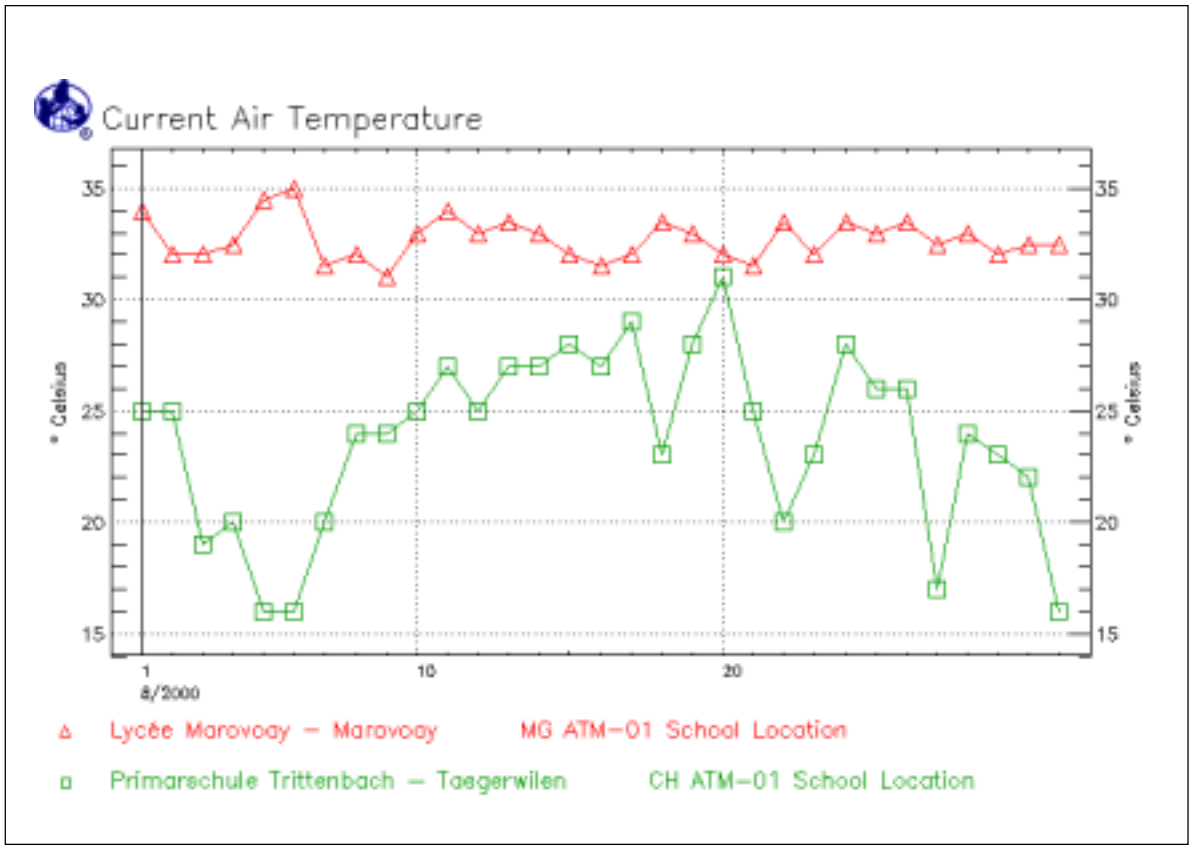
July 2000 Graphs – Denmark and Macedonia



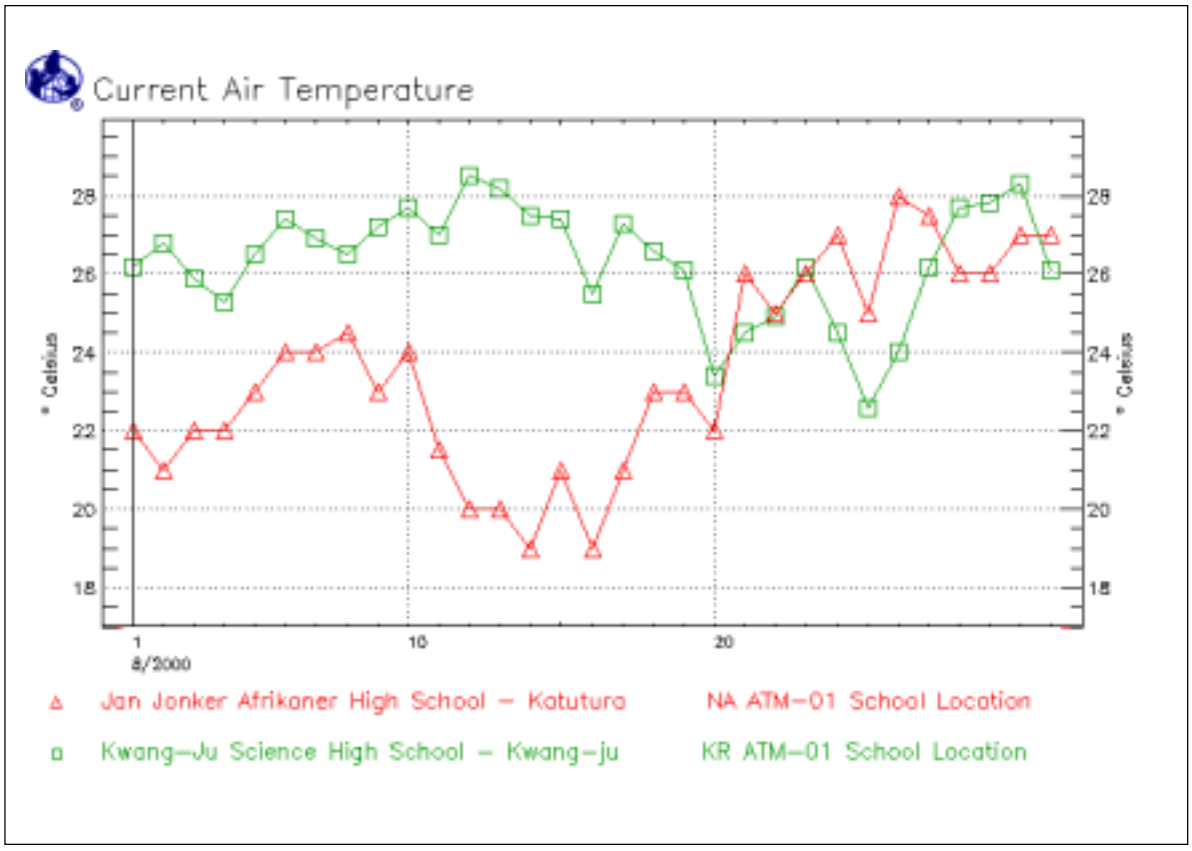
July 2000 Graphs – Argentina and Spain



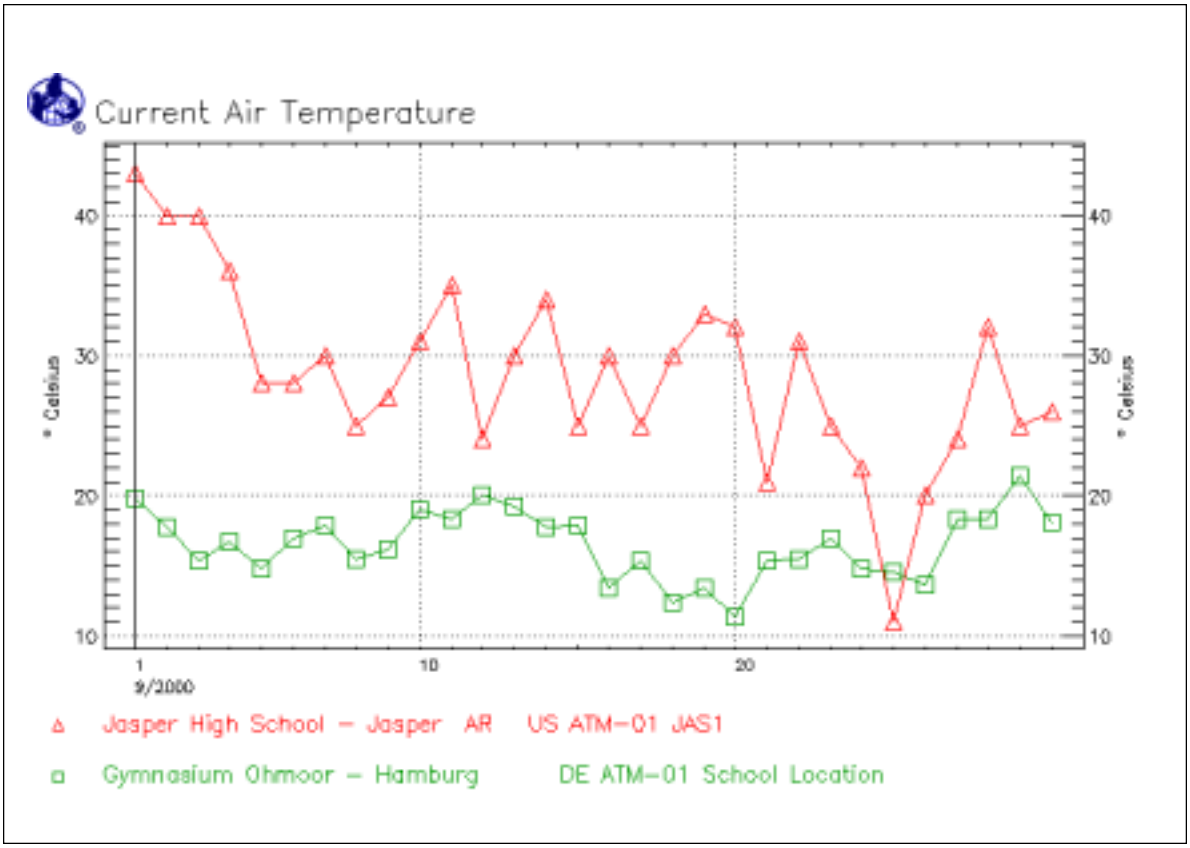
August 2000 Graphs – Madagascar and Switzerland



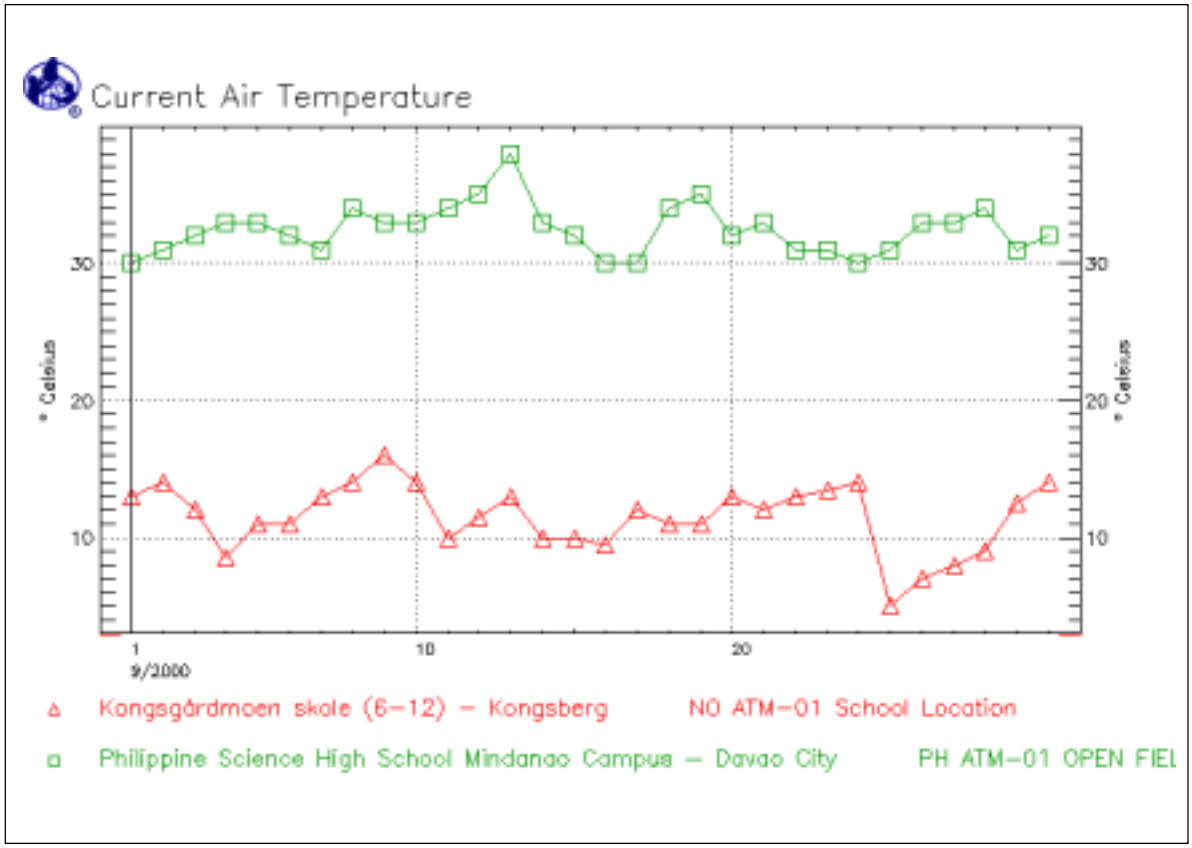
August 2000 Graphs – Namibia and South Korea



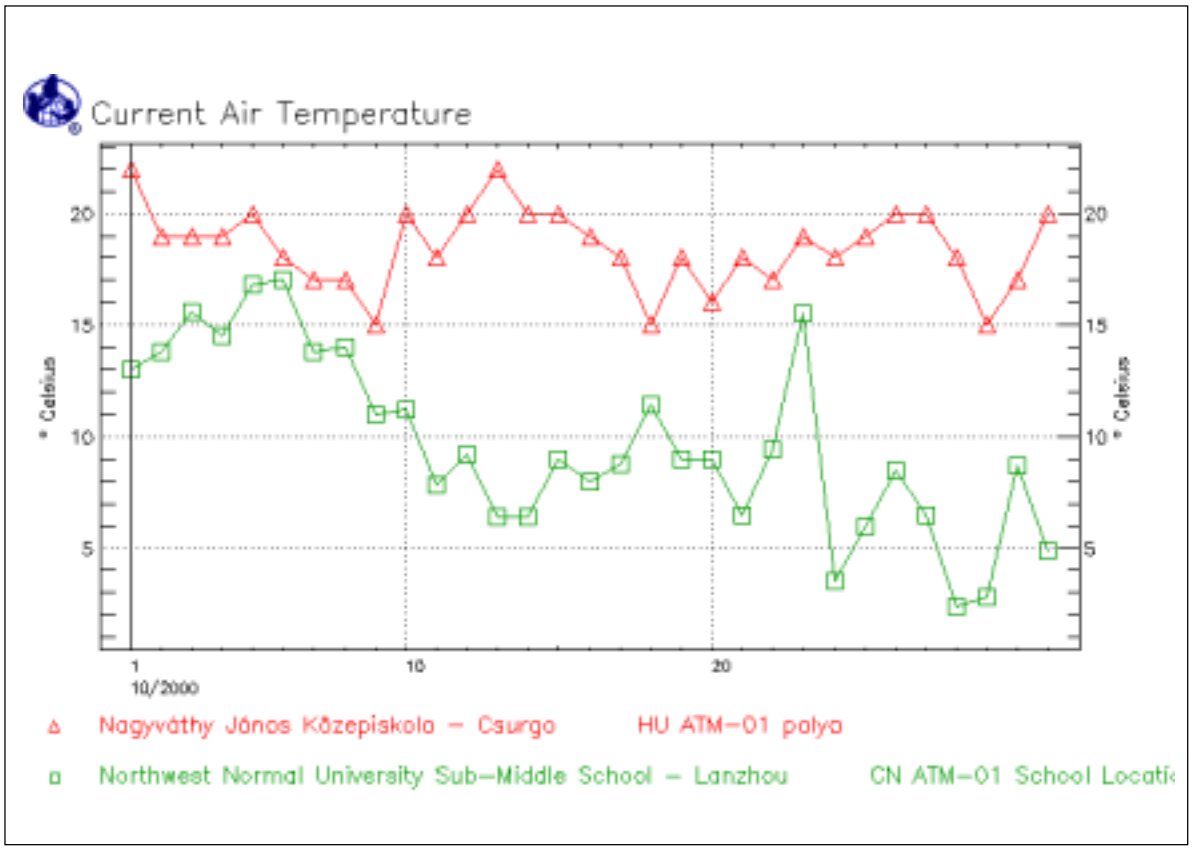
September 2000 Graphs – Arkansas, USA and Germany



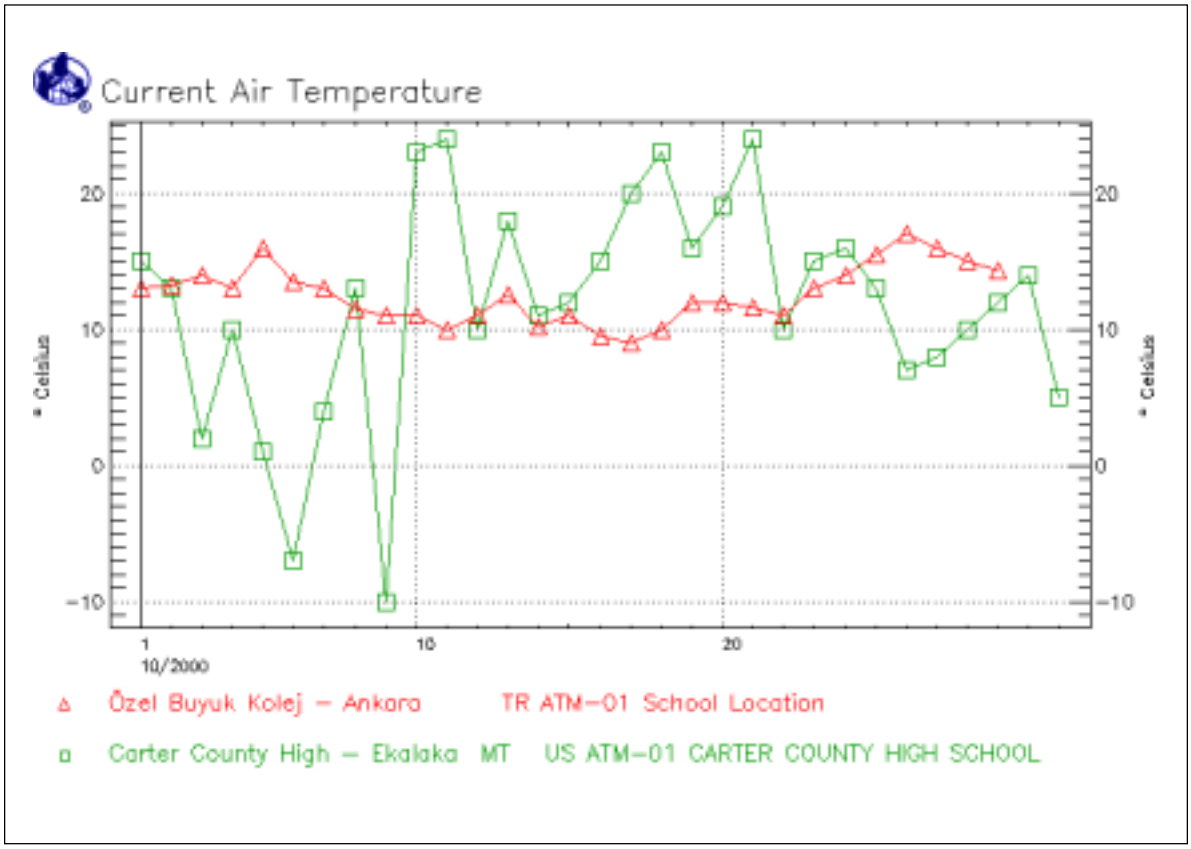
September 2000 Graphs – Norway and Philippines



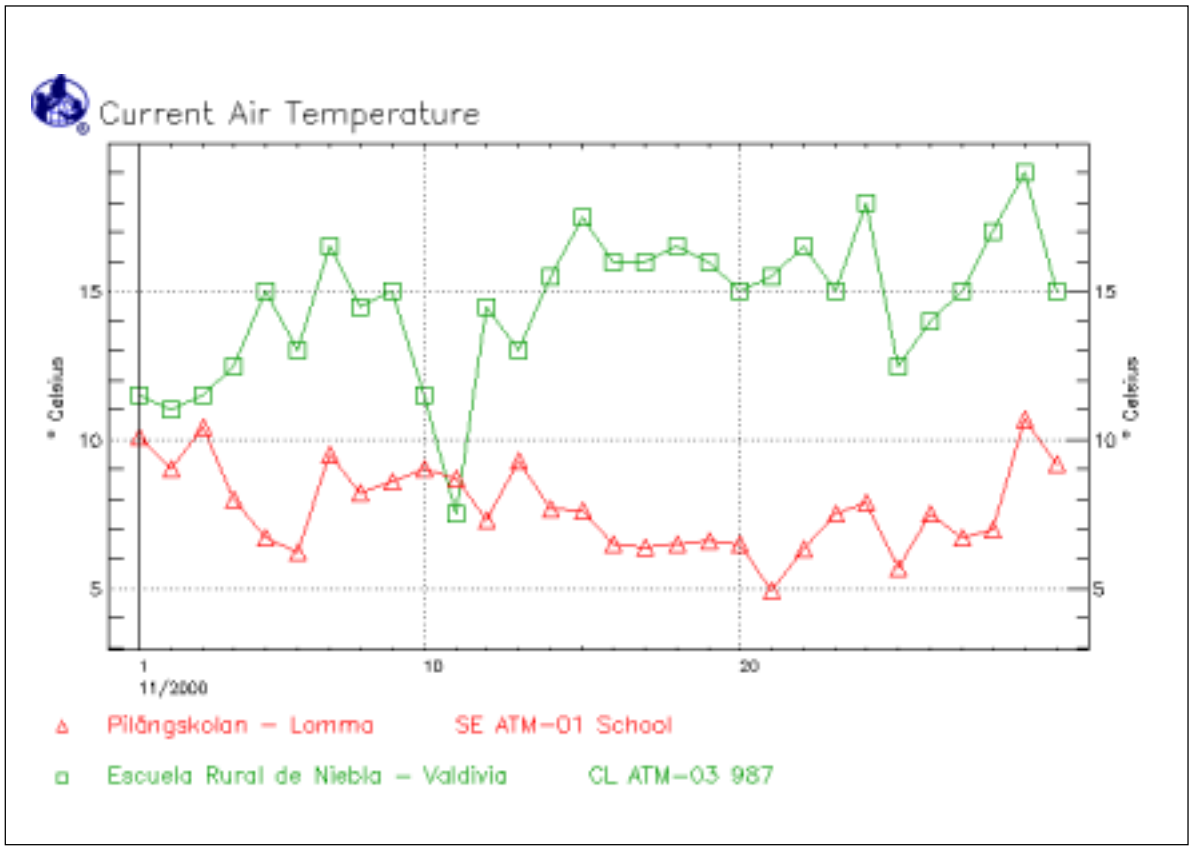
October 2000 Graphs – Hungary and China



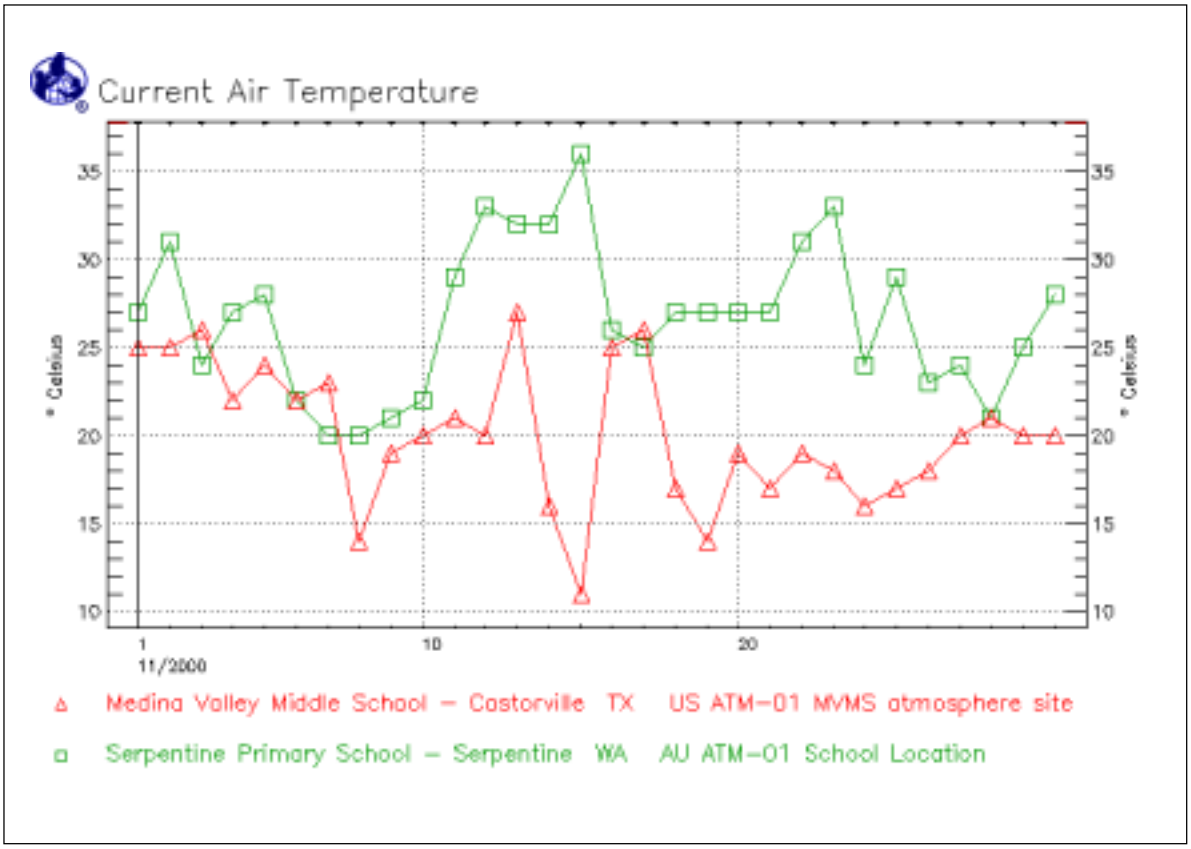
October 2000 Graphs – Turkey and Montana, USA



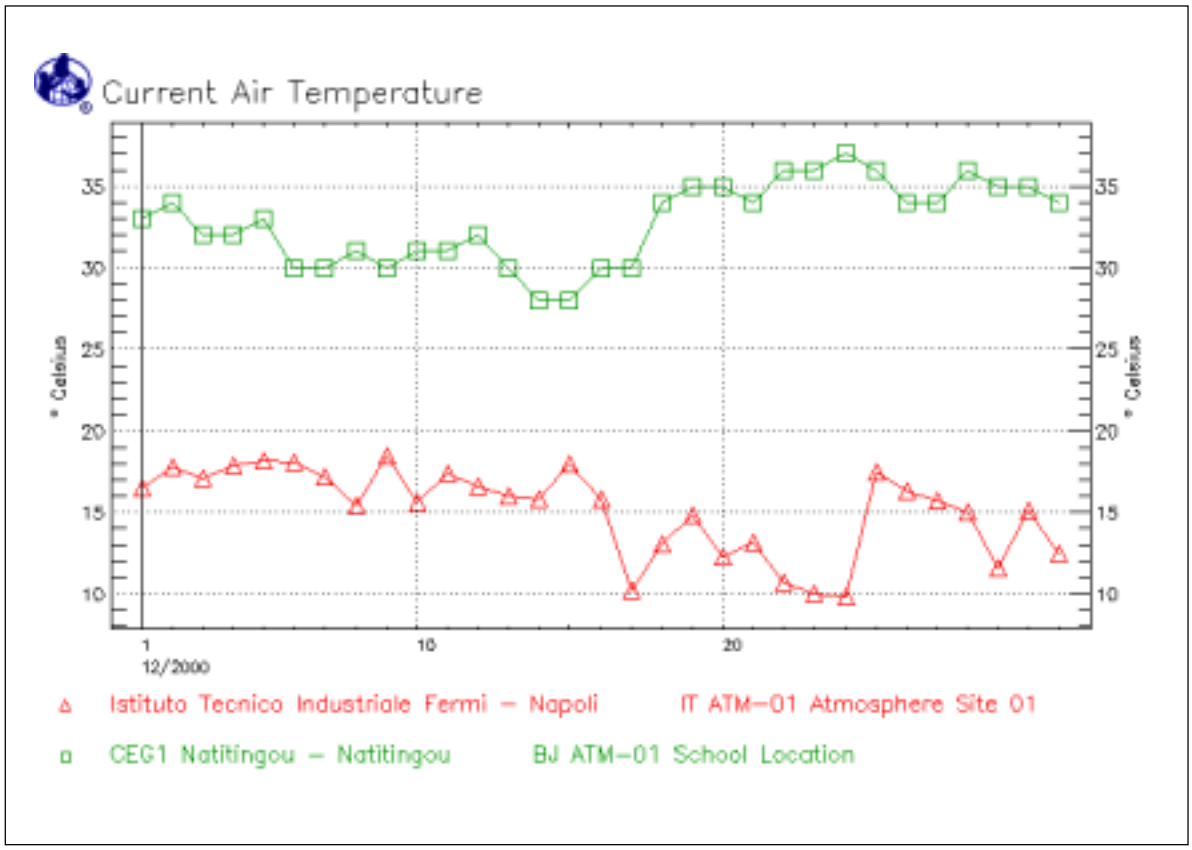
November 2000 Graphs – Sweden and Chile



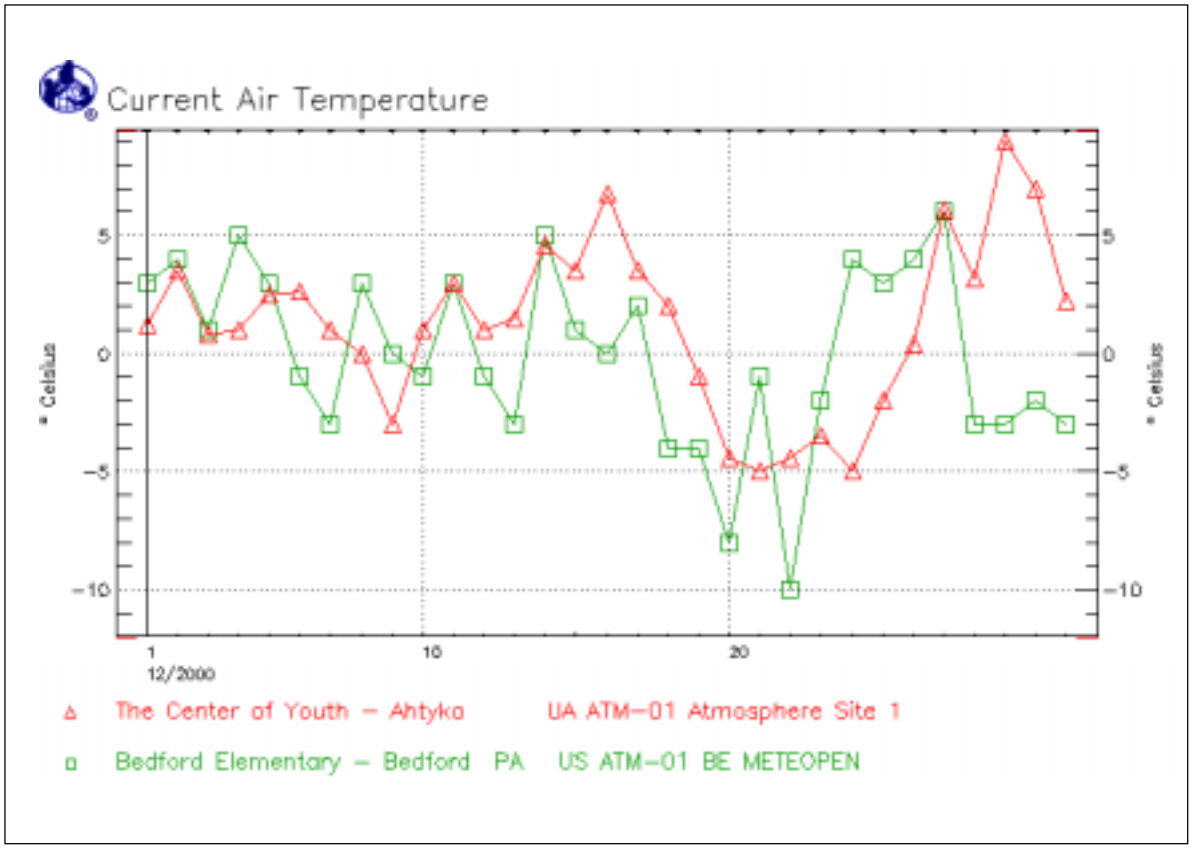
November 2000 Graphs – Texas, USA and Poland



December 2000 Graphs – Italy and Benin



December 2000 Graphs – Ukraine and Pennsylvania, USA



Primary

LA 4: Where is the Coolest Place?

Purpose

To introduce students to spatial analysis of temperature

Student Outcomes

Students will be able to work together to create a map of soil temperature variation, group temperatures on the map, and identify patterns.

Overview

Students will create a hypothesis about temperature variation in a 10 by 10 meter area, collect soil temperature data, record the temperature data on a map, identify groups of temperature values, and examine their map to confirm or refute their hypothesis.

Time

30-40 minutes to collect data

30 minutes to analyze data

Level

Primary 2-3

Key Concepts

Everybody can do science.
Teamwork is important.
Accurate data make comparisons possible.
Data can be analyzed spatially using maps.
Properties of materials change.

Skills

Making and *testing* a hypothesis
Measuring temperature
Following instructions
Collecting data
Recording data
Organizing data
Grouping numbers

Processes

Spatial analysis
Student inquiry
Scientific method

Materials and Tools

Ball of string (140 m)
2 sets of 36 cards labeled 1-36
36 nails (approximately 6 cm) or weights to hold down cards
Measuring tape
Soil thermometer(s)
Marker for each student group
Copy for each student of *Where is the Coolest Place? Work Sheet*
1 transparency of the *Where is the Coolest Place? Work Sheet*
Colored pencils
GLOBE Science Log

Preparation

Students should be familiar with the *Soil Temperature Protocol.*

Prerequisites

None

Background

Scientists map data to identify a spatial pattern in a data set, to find relationships between data taken from one area to data taken from another area, or to identify data that have similar regional patterns. This exercise allows students to begin the process of mapping and making spatial comparisons by having students group temperature readings taken over a 10 by 10 meter area. They will then attempt to identify the variables that may lead to the spatial variations.

Task – Map the Temperature
Make a map of spatial soil temperature variation.

Preparation

1. Locate a 10 by 10 meter area outside that will have variable air and soil temperatures. Your area should include, if possible, areas in shadow and sun, under trees or bushes and in the open, over grass and bare earth, in tilled soil or compacted soil.
2. Using the measuring tape and string, lay out a grid ten meters square. Mark the grid with the numbered cards every two meters (see the Work Sheet layout). Use nails or weights to anchor the cards to the ground. For younger students, you may want to layout the complete grid with string. For older students, the outline in string and the cards placed at intervals may be enough for them to transfer the data to their Work Sheet.
3. Each student group should be provided with a set of cards or a list of numbers for the points where they will collect data.
4. Review the soil temperature protocol with students, if necessary.

What To Do and How To Do It

1. Sit around the edge of the grid. Place your Work Sheet in front of you. Notice that the numbers on the Work Sheet are the same as the numbers on the grid. We want to take data on the ground and illustrate our data on our paper. To do this accurately, your group must match the place where the temperature is taken on the ground to the correct numbers on the paper.
2. With a pencil, lightly draw on your Work Sheet over the grid boxes a map of the 10 by 10 meter area. Draw in trees, bushes, grassy areas, paths, etc.
3. Discuss the variables that can affect temperature: time of day, weather conditions, soil characteristics, land cover, etc. Record your observations about the variables that may affect your plot in your GLOBE Science Log.
4. Make a hypothesis of what you will find. Using a pencil, draw a circle on your Work Sheet around the area or areas that contain the numbers where you think the coolest temperatures will be. Why do you think these areas will be cooler?
5. Your group has a set of cards identifying the numbers for which you will collect data. Identify the points on the grid for which your group is responsible.Using your thermometer, take turns collecting temperature data from each numbered point on the graph. Make sure you follow the protocol for collecting the data so that your data may be compared with that of the other students. Record the temperatures on the cards on the ground and on your Work Sheet.

What's the Coolest Spot?

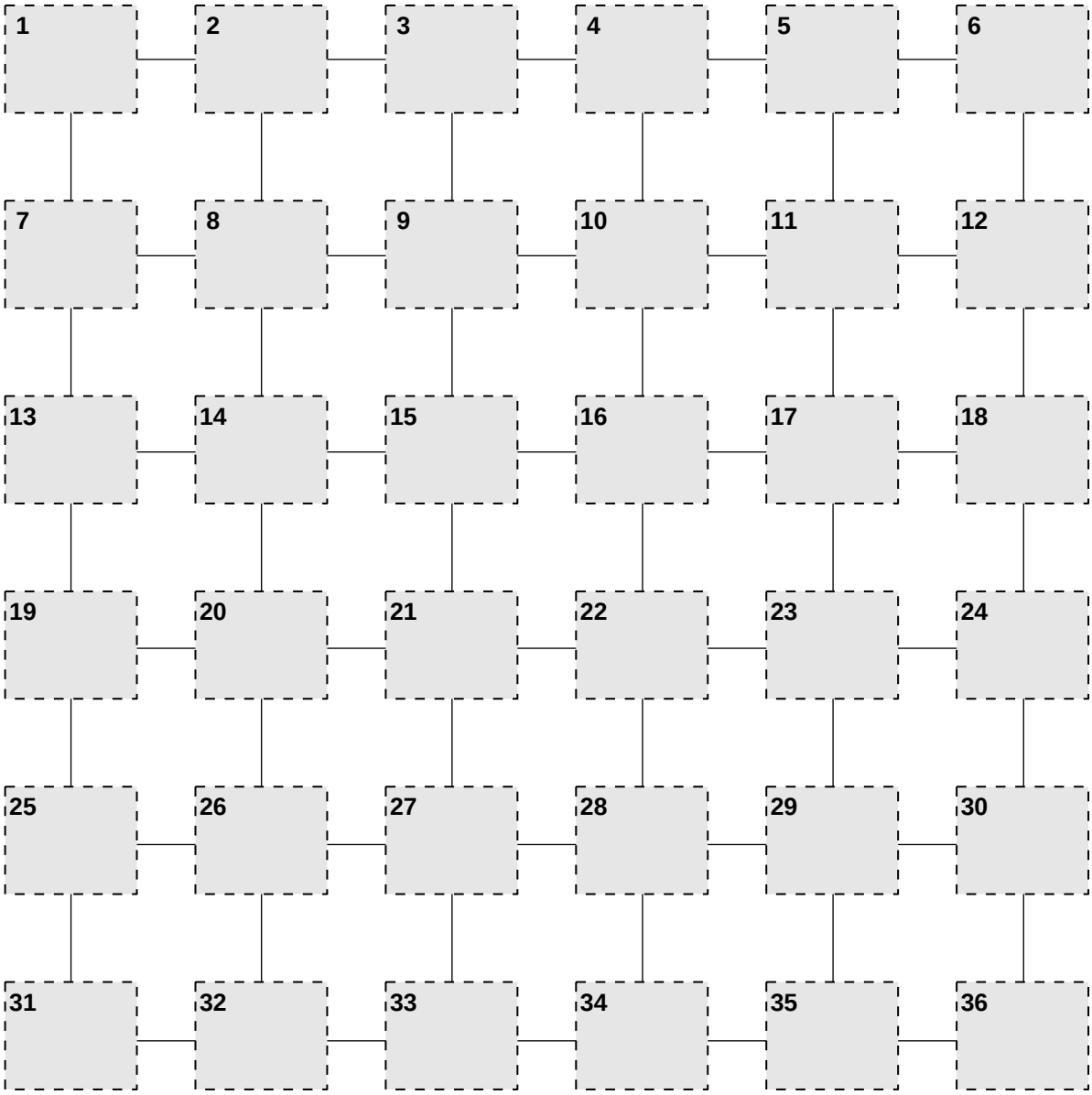
1. Transfer the data from all of the student groups onto a transparency.
2. Have each student copy the temperatures onto their own Work Sheet if they do not have them all recorded.
3. What is the highest temperature recorded? What is the second highest? These numbers will be the *High Temperature Group*.
4. What is the lowest temperature recorded? What is the second lowest? These numbers will be the *Low Temperature Group*.
5. With a blue pencil, draw a circle around an area that includes all of the *Low Temperature Group*. Lightly color the area inside the circle. All of the colored area should contain temperatures in the *Low Temperature Group*.
6. Is this area similar to the area that you guessed would be the coolest?
7. What do you think the temperature would be if we took more data from inside this blue area?
8. With a red pencil, circle the area that contains all of the *High Temperature Group*. Shade in the area inside the circle.
9. What do you think the temperature would be if we took more data from inside this red area?
10. If you were a mouse and wanted to stay cool during the time today when you were recording temperatures, where would you make your home? Where would you make your home if you wanted to stay warm? Do you think this might change at different times of day, during different weather, or different seasons?

Further Investigations

1. Have students repeat the activity during a different time of day or compare their data with another class who samples at a different time.
2. Develop a protocol for sampling air temperature on the grid. Compare your soil temperature map to your air temperature map.
3. Try different sampling techniques. Does it make a difference if you sample more or less points?

Where is the Coolest Place

Work Sheet



Highest Temperature	2nd Highest Temperature	Highest Temperature Group
Lowest Temperature	2nd Lowest Temperature	Lowest Temperature Group

Middle

LA1: Dancing with Data

Purpose

To introduce students to the inquiry process and data analysis

Student Outcomes

Students will learn to make observations from GLOBE graphs, create good research questions and form an hypothesis.

Overview

Using GLOBE data, students will form research questions and hypotheses that may be developed into research projects.

Time

40-50 minutes for each of 3 tasks

Note: Tasks may be repeated with other sets of data available in the GLOBE Source Book or on the GLOBE Web site.

Level

Middle: Grades 4 and up

Key Concepts

- Careful work and records help determine reasons for varying results.
- Explanations involve observations.
- Evidence and logic are used to back claims.
- Similar steps are used to conduct investigations.
- Variables affect outcomes.
- Expectations can affect outcomes.
- Unexpected findings lead to new investigations.
- Clear communication is important in science.

Skills

Organizing data
Recognizing and *describing* patterns
Estimating
Interpreting graphs
Forming good research questions
Stating a testable hypothesis

Processes

Scientific method
Student inquiry

Materials and Tools

GLOBE Science Log
GLOBE Source Book
Pencils
World atlas (recommended)

Preparation

If students are not familiar with basic graphing, they should do the Primary Inquiry activities. It may also be useful for students to learn the protocols for collecting the GLOBE data they will be examining.

Prerequisites

Ability to read a line graph

Preparation

Students will need to view the various graphs and maps from the GLOBE Data Source Book. This can be done in several ways. Since it is usually more productive to work through these exercises as a small group, copies of the materials may be printed for each group. Teachers may also make overheads so the class can discuss the graphs together. If access to computers is available, the materials may be accessed directly from the GLOBE Data Source Book CD by students using a computer. If internet access is available, students may want to access the data of the schools in this exercise online so that they can manipulate the graphs. This allows students to begin using the tools on the Web site in a focused fashion.

Teachers may choose any of five data sets for these activities: atmosphere, soil temperature, soil moisture, basic hydrology, or advanced hydrology. We recommend teachers choose a data set their students are familiar with. If they know the protocols for collecting the data, it will be easier for them to understand the data. The activities may be repeated with different data sets as students begin new GLOBE protocols.

Task 1 – Make scientific observations about GLOBE data sets

What To Do and How To Do It

Examine the graphs and tables from the GLOBE Data Source Book. Use the suggestions below to help guide you in making some observations about these data. Write your observations, and any questions you have about the data, in your GLOBE Science Log.

Making Observations

1. Begin by listing the variables displayed on the various graphs. What range of values would you expect to find for each type of data? What type of pattern would you expect to see on a graph? Create a table with these headings in your Science Log to begin your thinking about these data.
2. Pay particular attention to the range of values displayed on each graph. Do any of the graphs seem to have generally higher or lower values than either what you predicted or when compared to the other graphs?
3. Look for *anomalies*, data points that look significantly different from the others, in the data sets. Do you suspect some values may be incorrect? From your own experience, can you think of how an error could have been made in collecting or recording these data? Assuming that the data are accurate, what could have caused a particular anomaly?
4. Look for patterns. Do the data tend to repeat in some type of pattern? For instance, is there a seasonal temperature or precipitation pattern? Is this what you expected?
5. Look for trends. Can you find examples of data that seem to be generally going up or down over a long period of time?
6. Look for relationships. Examine the graphs having two or more variables. Do the data seem to follow each other? Or do they seem to move in opposite directions? Can you find an example of variables that have a direct relationship (both sets of data move up or down at the same time) or an inverse relationship (when one goes up the other goes down)? Are some data sets not at all related?

Types of data found on the graphs	Expected range of values for this type of data	Expected pattern over 1 year (draw what you expect a graph of this data to look like over one year)

Task 2 – Analyze GLOBE graphs and develop appropriate questions for research

What To Do and How To Do It

Questions and Examples

Some of the observations you made may have been written as questions. Others could easily be rewritten as questions. Research questions can generally be grouped into four categories:

1. How do these data change over time?
   Example: I observed that in 1998 the dissolved oxygen at my school seemed to be higher during the summer months. Is dissolved oxygen always higher during the summer?
2. How do these data vary from place to place?
   Example: I observed that the precipitation pH seemed to be low in the Northeast United States. Where would I find similar pockets of low pH precipitation. How are these areas related?
3. How are these two (or more) sets of data related to each other?
   Example: I observed that one area of MUC 0122 seems to have a lot of rain and cold winters. Do most MUC 0122's have high precipitation and cold winters?
4. How might these data relate to another activity or set of data?
   Example: We are not supposed to plant these seeds until the last danger of frost has past. About what date should we be able to plant these seeds?

Analyzing a Research Question

Read the following questions that have been proposed for research projects. Make notes in your science journal about whether you think the question would make a good project and why. Think about the following issues:

1. Is the question interesting and not trivial?
2. Are data available to answer this question?
3. Is it clear what the question is asking?
4. Does the question address the problem you are trying to solve?
5. Does this question have an answer?
6. Could you answer this question with a reasonable amount of time and resources?

Question 1:
Was the soil temperature for the week of March 21 at my school less than the air temperature?

Question 2:
Does an increase in cloud cover cause a decrease in temperature?

Question 3:
Is the average daily range in air temperature greater in high elevations than in low elevations?

Question 4:
Is it more likely that the maximum soil temperature will be higher or lower than the current air temperature in areas of high soil moisture and high elevation?

Discuss your analysis of the questions above with your classmates. Could some of the questions be changed to make them better research questions?

Examine some of the observations and questions that you made in your Science Log from Task 1. Do you have questions concerning how a variable changes over time, over space, in relation to another variable or in relation to something else? Try to think of a question to fit into each of these categories. Analyze your own questions to determine if they would make good research projects.

Task 3 – Define a Hypothesis

What To Do and How To Do It

Hypotheses and Examples

After you have found a good research question, you will want to develop a hypothesis to guide your research. A hypothesis is a statement that you can test. Think about the following things when you write a hypothesis.

1. Are the terms in the hypothesis clear and well-defined?
   For example: what do you mean by 'high elevation', 'close to the ocean', or 'low latitude'?
2. What variable(s) are being tested?
   Remember, a variable is something that changes over time, space, or in relation to another variable.
3. What variable(s) are being controlled?
   What variable(s) are not being tested that may effect the results of your research? It is often not practical or possible to control every variable. Which one(s) are most important?
4. What evidence would you need to find to support or refute this hypothesis?

Make a statement: "To support this hypothesis I will need to find that…."

Read the following hypotheses that have been proposed for research projects. Discuss how you would improve each hypothesis to make it more testable. Record your suggestions in your Science Log.

Hypothesis 1:
Schools at high elevations will have lower temperatures than schools at low elevations.

Hypothesis 2:
pH always rises in the Fall.

Hypothesis 3:
Clay soils have a greater temperature range than sandy soils.

Hypothesis 4:
Streams have higher dissolved oxygen than ponds or lakes.

Create a well-defined hypothesis from at least two of the questions that you developed in Task 2. Share your hypotheses with a partner to see if they have any questions about the terms, variables, or objectives of your hypotheses.

Middle

LA2: Which is the Rainiest Place?

Purpose

To introduce middle students to using percentage as a technique for statistical analysis

Student Outcomes

Students will be able to calculate and use a percentage to analyze data.

Overview

Students will organize and analyze GLOBE data using percentages to ask a research question and to accept or refute their hypotheses.

Time

45 min

Level

Middle: Grades 5 and up

Key Concepts

- Explanations involve observations.
- Evidence and logic are used to back claims.
- Similar steps are used to conduct investigations.
- Expectations can affect outcomes.
- Unexpected findings lead to new investigations.
- Communication is important in science.

Skills

- *Measuring, collecting* and *organizing* data
- *Recognizing* and *describing* patterns
- *Estimating*
- *Interpreting* graphs
- *Interpreting* tables
- *Calculating* percentage
- *Using* statistical methods to describe, analyze, and draw conclusions

Processes

- Scientific method
- Student inquiry

Materials and Tools

- GLOBE Science Log
- GLOBE Source Book
- Calculator (optional)
- *The Rainiest Place Work Sheet*

Preparation

If students are not familiar with basic graph interpretation, they should do the *Dancing with Data Learning Activity.*

Prerequisites

Basic arithmetic: adding, subtracting, multiplying, dividing

Reading a line graph

Task – The Rainiest Place
Determine the rainiest place from among four schools.

Preparation

Students will need access to the graph below and the data used to make the graph. These may be viewed or printed from the GLOBE Data Source Book or GLOBE Web site.

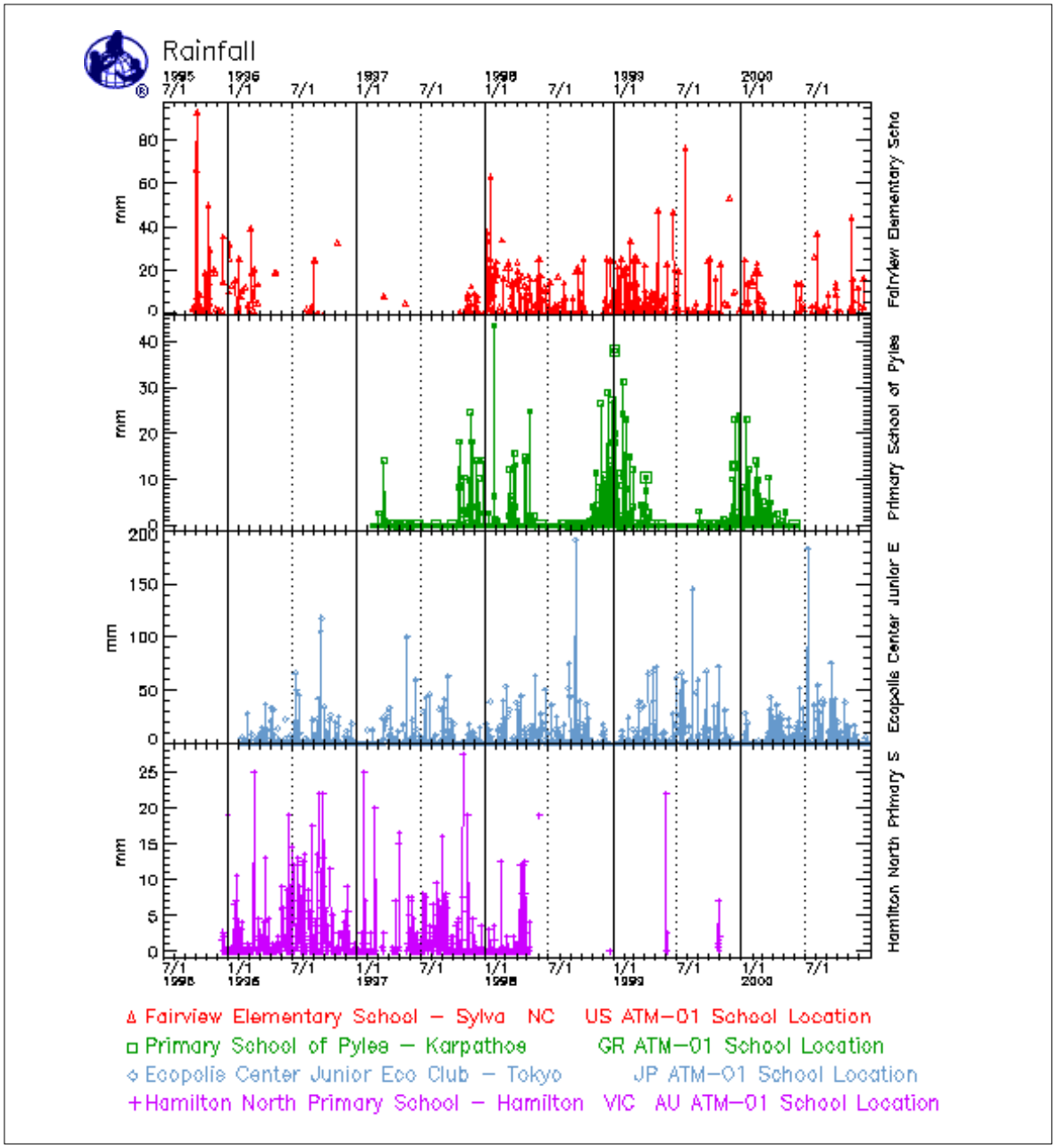
What to Do and How to Do It

Observation

Examine the graphs of rainfall data below. What do you notice about the 4 data sets? Write your observations in your GLOBE Science Log.

Research Question

Which of the four schools has the rainiest weather? Is this a good research question? How could you make this question better? Write a better research question.



Hypothesis

Define an hypothesis for your question and a method to answer your question or use the sample hypothesis below:

A Sample Hypothesis: (*fill in the name of one of the schools*) is the school where it is most likely to have a day with some rainfall.

Thinking about a Methodology

1. How could you test this hypothesis?
2. What are the challenges you would face when trying to compare these 4 data sets?
3. The table of data for these four schools is in the GLOBE Data Source Book or may be accessed on the GLOBE Web site. Devise a method for testing your hypothesis and outline the steps of your method in your Science Log.
4. Follow your method to determine the school most likely to have a day with some rainfall.

Once you have completed your project, complete *The Rainiest Place Work Sheet*. Compare the method you chose to the method outlined on the Work Sheet.

The Rainiest Place
Work Sheet

1. Record the names of the schools on the table below.
2. Count and record the total number of days that students at each school collected rainfall data. (Use the table in the GLOBE Data Source Book)
3. Count and record the total number of days that students at each school reported a rainfall value above 0.0 mm.
4. Calculate and record the percent (%) of days that it rained at each school. (% = total number of data points divided by the total number of days it rained multiplied by 100)
   Note: Percentage indicates how many times something occurs out of 100.

Name of School	Number of days students collected rainfall data	Number of days when some rainfall fell	% of days when it was rainy

Using the Data

Were there any problems you faced when using these data?

Were there any decisions you had to make that were not covered in the instructions?

How might these decisions have affected the results?

Comparing Methods

Which school was chosen as the rainiest by each method?

Method 1: Visual estimate _____

Method 2: Outlined by student _____

Method 3: Statistical calculations _____

1. Did each method address the question?

2. What was the difference between the methods?

3. What was the advantage and disadvantage of each method?

4. How important is it to outline your method clearly?

Middle

LA 3: Mean, Median, Mode

Purpose

To introduce middle students to appropriate uses of the mean, median and mode for statistical analysis.

Student Outcomes

Students will use be able to use mean, median and mode to analyze data.

Overview

Students will compare results from using the mean, median and mode to analyze GLOBE dissolved oxygen data.

Time

45 minutes per task

Level

Middle: Grades 5 and up

Key Concepts

- Results of similar investigations vary.
- Careful work and records help determine reasons for varying results.
- Explanations involve observations.
- Evidence and logic are used to back claims.
- Similar steps are used to conduct investigations.
- Clear communication is important in science.

Skills

- *Organizing* data
- *Recognizing* and *describing* patterns
- *Estimating*
- *Interpreting* graphs
- *Interpreting* tables
- *Calculating* central tendency
- *Creating* and *interpreting* histograms
- *Using* statistical methods to describe, analyze, and draw conclusions

Processes

- Scientific method
- Student inquiry

Materials and Tools

- GLOBE Science Log
- GLOBE Source Book
- *Histogram Work Sheet* (3 per student or student group)

Preparation

If students are not familiar with basic graph interpretation, they should do Middle Learning Activity 2: *Dancing with Data.*

Prerequisites

Basic arithmetic: adding, subtracting, multiplying, dividing

Reading a line graph

Preparation

Students will need to examine the graphs of dissolved oxygen and the data used to make these graphs for each of the three schools in Task 2. These materials may be viewed or printed from the GLOBE Data Source Book CD or online at the GLOBE Web site.

Task 1 – A Class Representative
Choose a person to represent the height of your class

What To Do and How to Do It

Brainstorm ways to find the person in your class who best represents the 'class height'.

Think about how you would choose one person from your class whose height is typical of all of the students in your class. Would you choose the tallest person or the shortest person? Those students would not be *representative* of the height of the class because most students are in the middle. What would be the best way to find the person who was right in the middle?

After a discussion of various ways this might be done, compare the methods the students devised to the methods below.

Thinking and Examples

Scientists have some standard ways of choosing 'the one in the middle', or the best representative of their data set. This representative number is called the *central value*.

Median:
Definition: The middle value of a set of values.

Find the median height for your class by lining up everyone in the class from shortest to tallest. Count off from both ends to find the person in the middle.

Mode:
Definition: The most frequently occurring value of a data set

Have everyone write their height on the board. Does one height occur more often than others? These people represent the mode.

Mean:
Definition: The mean, or arithmetic average, is the sum of a group of numbers, divided by the number of numbers in the group.

Find the mean by adding together everyone's height, then dividing by the number of students in the class. The person closest to the mean would represent the class.

Was the same person chosen every time as class representative? What were the advantages and disadvantages of each method?

Task 2 - Representative Numbers
Choose a number to represent a data set

What to Do and How to Do It

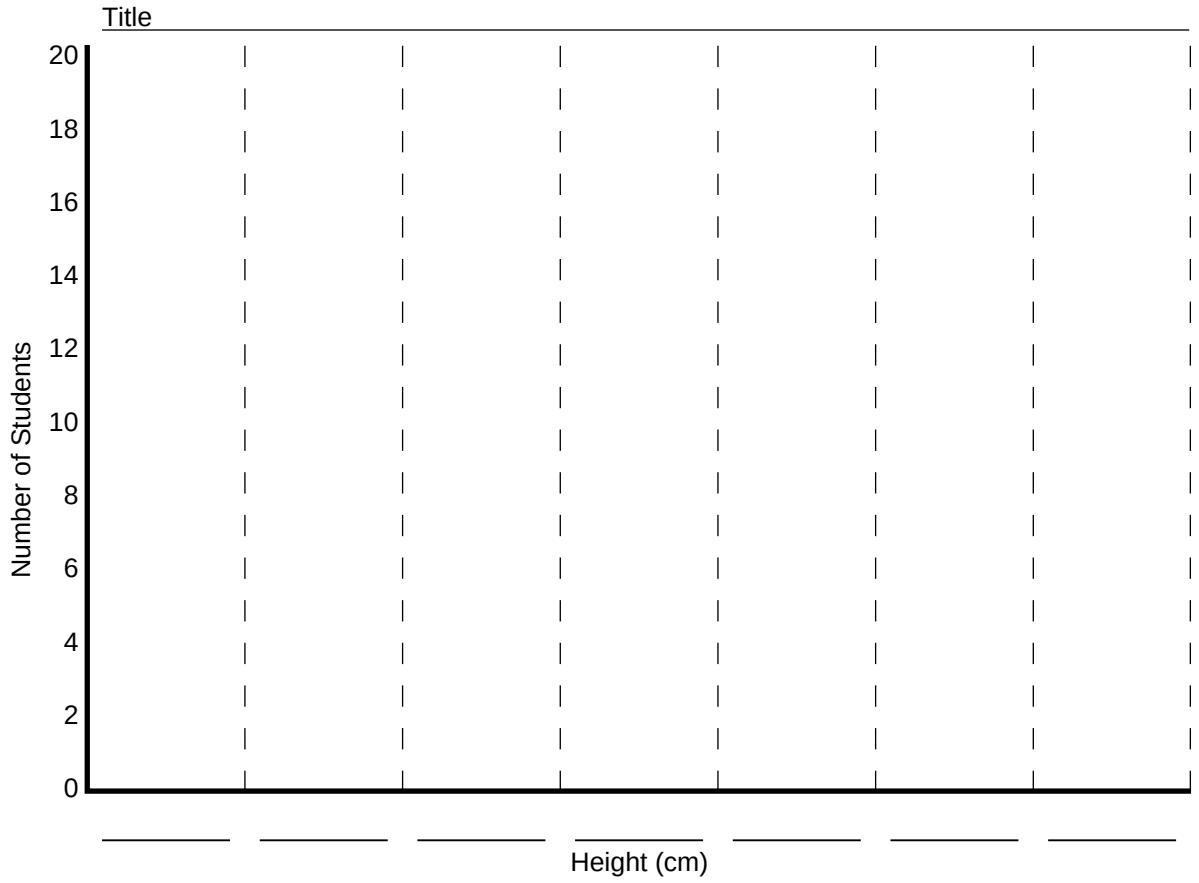
1. Examine the graphs of dissolved oxygen in the three data sets from the GLOBE Data Source Book. Do a visual estimate of the middle value for each data set.
2. Find the mean, median, and mode for each data set.
3. Evaluate the results using each method.
   a. Were the mean, median and mode for any one school the same?
   b. Were the mean, median or mode close to your estimate?
   c. Which do you think best represents the data set?
   d. How could you evaluate the best way to represent the data set?
4. Use the *Histogram Work Sheet,* to help in your evaluation of the different methods.

School Name	Estimate	Mean	Median	Mode
Chemisches Institut Dr. Flad, Stuttgart, Germany				
Crescent Elk School, Crescent City, California, USA				
Hartland Consolidated School, Hartland, Maine, USA				

Histogram
Work Sheet

Instructions

1. Put the data from the first school in order from the lowest to highest values.
2. Calculate the range.
3. Classify the data into 7 groups, each with an equal range. These groups are called bins.
4. Write the interval below each column (bin). **Note:** A bin contains the first number in the interval and goes up to the last number. (= or > the first number and < the second number.
5. Shade in the bin up to the number of students contained in that interval.
6. Draw a line approximating the shape of your histogram.
7. Put the mean, median and mode on the histogram.
8. Repeat the above steps for the other two schools.
9. Were the curves created by the 3 schools the same? What does this tell you about how the data were distributed? Were most of the values close to the mean?



Middle

LA4: Standard Deviation

Purpose

To introduce middle students to using standard deviation for analysis

Student Outcomes

Students will be able to use standard deviation to analyze a data set.

Overview

Students will organize and analyze GLOBE data using simple statistics, including standard deviation, to answer their research questions and to accept or refute their hypotheses.

Time

Task 1: 90 minutes

Task 2: 45 minutes

Level

Middle: Grades 5 and up

Key Concepts

- Results of similar investigations vary.
- Careful work and records help determine reasons for varying results.
- Explanations involve observations.
- Evidence and logic are used to back claims.
- Similar steps are used to conduct investigations.
- Expectations can affect outcomes.
- Unexpected findings lead to new investigations.
- Varying results may be trivial or significant.
- Communication is important in science.

Skills

- *Measuring, collecting* and *organizing* data
- *Recognizing* and *describing* patterns
- *Estimating*
- *Interpreting* graphs
- *Interpreting* tables
- *Calculating* central tendency
- *Calculating* and *interpreting* standard deviation
- *Creating* and *interpreting* histograms
- *Using* statistical methods to describe, analyze, and draw conclusions

Processes

- Scientific method
- Student inquiry

Materials and Tools

- GLOBE Science Log
- GLOBE Source Book
- Pencils
- World atlas (recommended)
- **Task 1**
- *How High Does Our Step Stool Need to Be? Work Sheet 1*
- *How High Does Our Step Stool Need to Be? Work Sheet 2*

Preparation

Students should have mastered the skills required in the preceding *Inquiry Learning Activities*

Prerequisites

Basic arithmetic: adding, subtracting, multiplying, dividing

Calculating mean

Task 1 – Reading the Rain Gauge
Determine how high your step stool needs to be to see the rain gauge at eye level.

What To Do and How To Do It

Problem:
Your rain gauge is mounted with your atmosphere shelter so that the top of the inner tube inside the rain gauge is two meters above the ground. It is too tall for the students to be able to read the rainfall amount at eye level, so they need to buy a step stool. How can you determine the best height for the step stool?

Use *Calculating Standard Deviation Work Sheet 1.*

1. Find the height of each member of the class.
2. Calculate the mean height of the class.
3. Fill in the Student Name (or number) and Height.
4. For each student, find and record the difference between the mean and the student height.
5. Square the difference (to get rid of negative numbers)
6. Record the sum of the differences squared.
7. Record the number of students in the class.
8. Calculate the average of the differences squared.
9. Find the square root of the average of the differences squared. This is the *standard deviation** (SD). 1 SD is defined as the mean of the data set + or – the standard deviation. If your class has a *normal distribution** 68% of the students in the class are within ± 1 standard deviation, 96% of the students are within ± 2 SD of the mean class height, and 99% of the students are within 3 SD of the mean class height.

Use *Using Standard Deviation Work Sheet 2.*

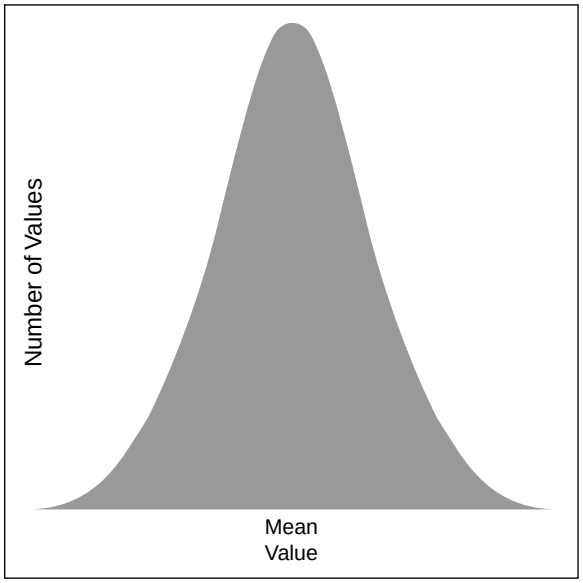
1. How high would the stool need to be so that 68% of the students could read the rain gauge at eye level no matter how much rain was in it?
2. How high would the stool need to be so that 96% of the students could read it?

Example:
The mean height of the class is 1.2 m (120 cm). One standard deviation is 0.2 m (20 cm). Therefore, students between 1.0 m (100 cm) and 1.4 m (140 cm) will be within 1 SD of the mean. In the 68th percentile, for the shortest student, at 1.0 m, to be able to read the rain gauge, at 2.0 m, the stool needs to be 1.0 meter tall.

Standard Deviation:
Definition: The standard deviation of a collection of numbers is the square root of (the difference between the mean of the squares of the numbers and the square of the mean of the numbers).

Normal Distribution:
Definition: A frequency distribution represented by a bell-shaped curve of the distribution of a series of values of a variable. A graph of the values has a single peak at the center which occurs at the mean for the set of numbers. The graph is symmetrical about the mean.

Figure IMP-L-1: Normal Distribution



How High Does Our Step Stool Need to Be?

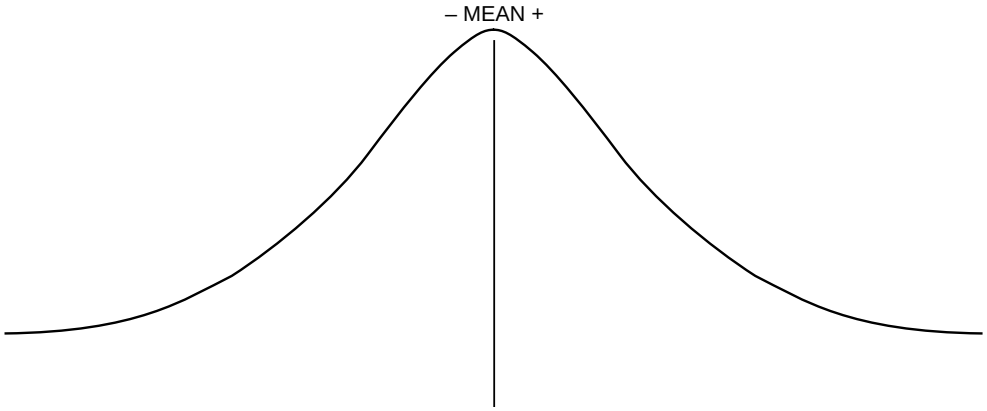
Work Sheet 1 – Calculating the Standard Deviation

Mean height of students in class = _____ cm

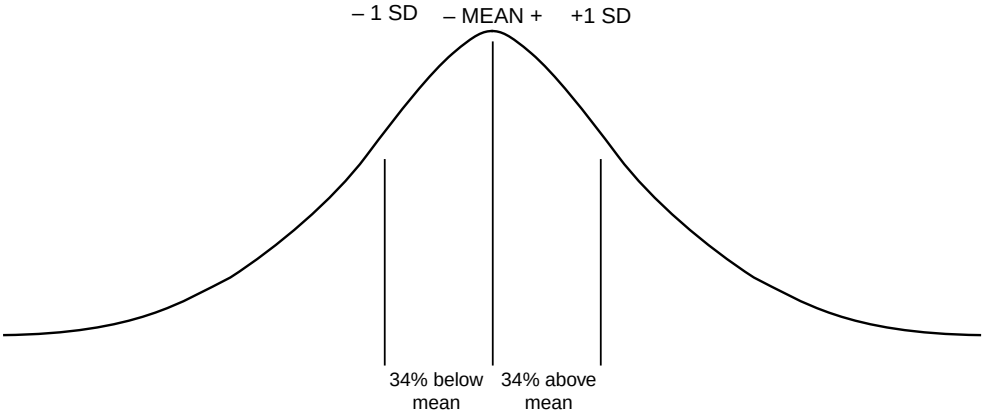
Student Name	Height (cm)	Difference (cm) between class mean and height	Difference Squared
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			
Total of the Differences Squared (T)			
Number of Students (S)			
Average of the Differences Squared (T/S)			
Square Root of the Average = Standard Deviation ($\sqrt{T/S}$)			

How High Does Our Step Stool Need to Be?

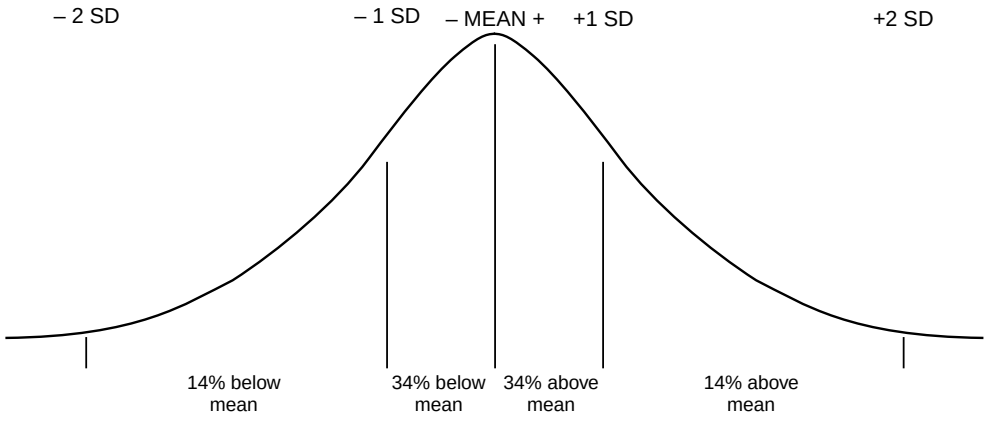
Work Sheet 2 – Using the Standard Deviation



1. How high does the stool need to be so 68% of the students can read it? _____



2. How high should the stool be so 96% of students can read it? (mean – 2 SD =_____cm)



Task 2 – Classifying pH Data
Determine how to classify the pH data

What to Do and How to Do It

Students at a school in the Northeast USA found that their average surface water pH for 2000 was 6.8. They wondered if their school had pH values that were low or high for their region, so they compared the surface water pH at their school with that of other schools in their region. They created a map and table of data for the area. See map/table of *Northeast USA Average pH 2000 below* or in Source Book.

Values for Northeast USA - Average Water pH 2000			
8.3	7.1	6.2	5.2
7.7	6.9	6.2	5.1
7.5	6.5	5.9	

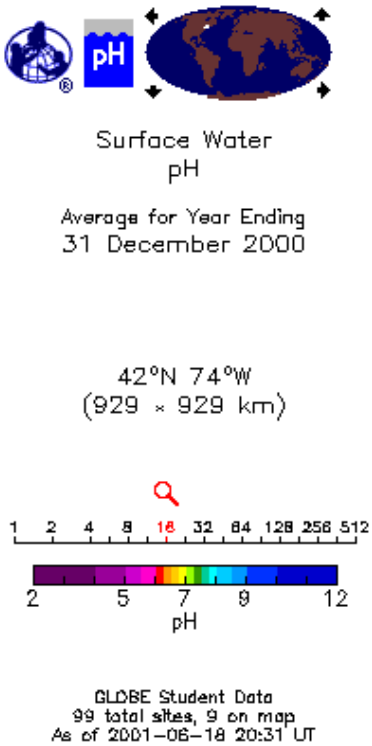
Within your group, look at the pH data and determine the values that would be considered 'high', 'medium' and 'low'.

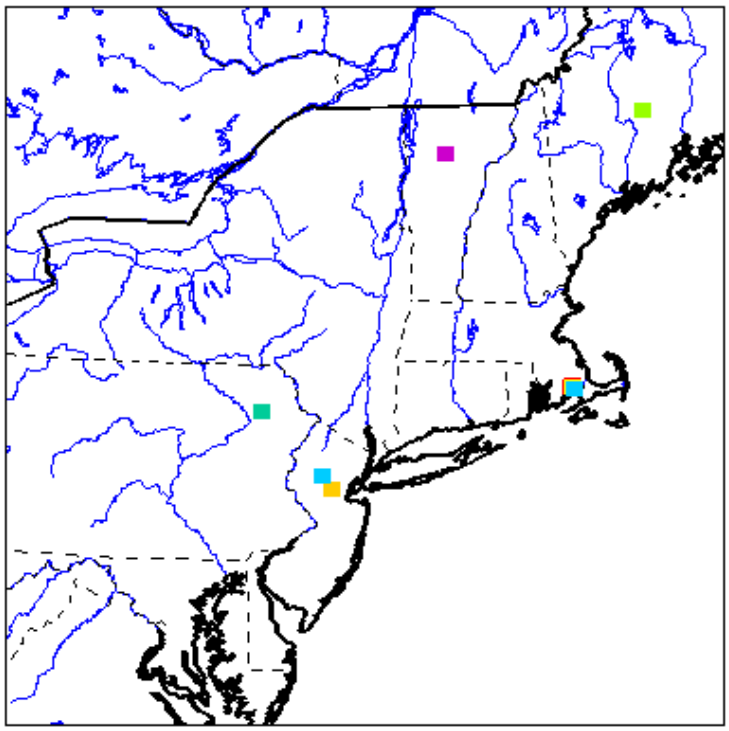
1. Share the results with other groups in the class. How were the determinations made? Were they consistent? What methods worked for determining the classes of data?
2. Calculate the mean and SD for this data set. Using one SD as the medium range, how do your classes compare? What are the advantages/disadvantages of using SD?
3. Did the students have *average* pH for their region?

Further Investigations

Students were interested in examining the pattern of surface water pH in Europe. They wanted to know where areas of low, medium, and high pH existed. How could they determine values for 'low', 'medium', and 'high'? See map/table of *Europe Average Surface Water pH 2000* in the GLOBE Source Book.

When they mapped pH values in Europe for 2000 they noticed only one school, Staatliche Realschule Burglengenfeld in Germany, showed up bright red on the map. Does this school have pH values outside 'normal' range for the area? See zoom of map of *Europe Average Surface Water pH*.





Middle

LA5: Analysis with Isopleth Maps

Purpose

To introduce students to making and using isopleth maps for analysis

Student Outcomes

Students will be able to create a simple isopleth map and use isopleth maps to interpret spatial variation in data.

Overview

Students will first learn to make a simple isopleth map. They will then use GLOBE data to create isopleth maps and use the maps created on the GLOBE visualization pages to explore regional climatic variations.

Time

40-50 minutes per task or map

Level

Middle; Grades 4 and up

Key Concepts

Isopleth maps are models of reality.
Results of similar investigations vary.
Variations in topography affect regional climate patterns.

Skills

Recognizing and *describing* patterns
Organizing data
Grouping
Estimating
Creating an isopleth map
Interpreting an isopleth map
Drawing conclusions

Processes

Student inquiry
Scientific method
Energy cycle

Materials and Tools

GLOBE Science Log
GLOBE Source Book
Pencil/eraser
Colored pencils
Task 1
Drawing an Isopleth Map Work Sheet
Task 2
Regional data map student templates
Atlas

Preparation

Have students examine some of the maps on the GLOBE visualization Web pages or in the GLOBE Source Book.

Prerequisites

None

Preparation

We can never gather data from every point on a map. An isopleth map is used to show patterns of data on a map or to fill in missing data. An isopleth map is a map with lines connecting points of equal value. These lines are called isolines. One common use of isopleth maps are weather maps that predict temperatures. The temperature ranges are illustrated with colors. An area with the same color shows a range of temperatures between two isolines. Another common type of isopleth map is a contour map, a map with lines connecting points of equal elevation.

Thus, an isopleth map is a hypothesis or model of what the map would look like if data were available.

Drawing your own isopleth maps is an excellent way to understand how some of these models are created and how to interpret them. For more information on how the GLOBE visualizations are created you can go to the Visualization Help Page.

Task 1
Draw a simple isopleth map.

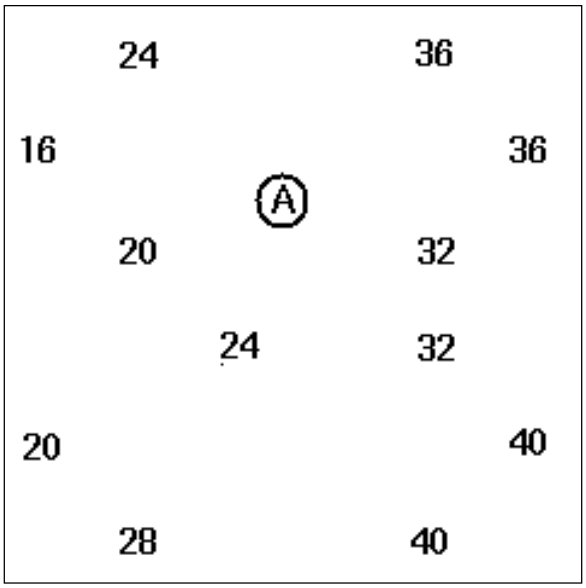
What To Do and How To Do It

Follow the instructions adapted from the GLOBE visualization pages to learn to create your own isopleth maps.

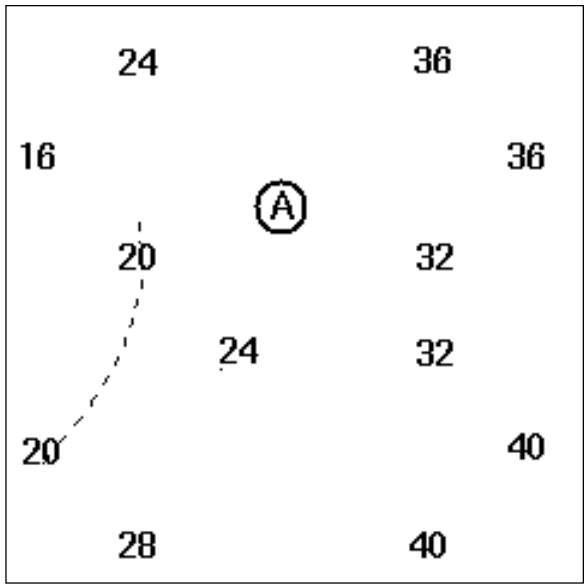
Drawing an Isopleth Map

We have plotted some temperature data points. It would be difficult to determine the value at point A (what do you think it is?) without drawing some *isolines* first. An isoline is a line connecting points having the same data value. An isoline connecting points of equal temperature is called an *isotherm*.

Since we have 2 data points that are 20, we can draw a line connecting them.

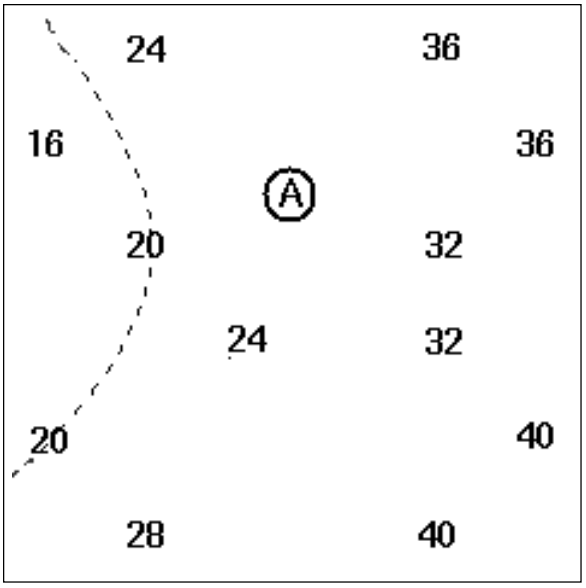


This is how the plot should look. What do we do now? There are no other 20 degree data points, but we do have two points in the upper left corner that are 16 and 24 degrees. We assume a line of *gradation* between the points. This is like a number line between the points. We assume the temperature between 16 and 24 uniformly rises. Since 20 is halfway between 16 and 24, we *interpolate*, or hypothesize, there is a 20 degree temperature point right in the middle between 16 and 24. Now we can extend our line between these two points.



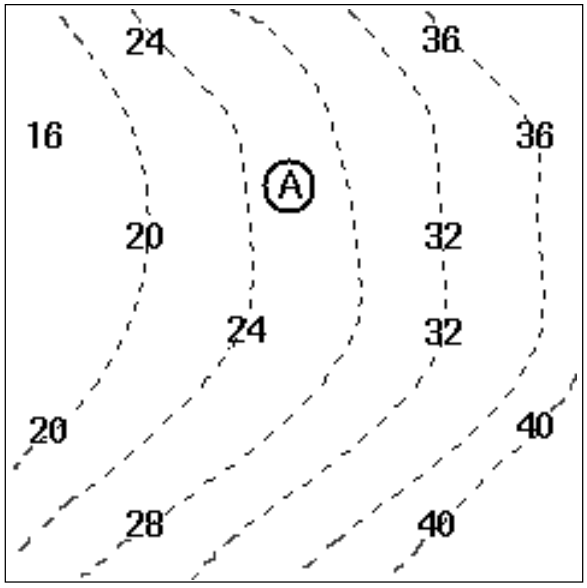
We have now completed the isotherm for 20 degrees. Any point to the *left* of the dashed line is colder than 20 degrees, and any point to the *right* of the line is warmer than 20 degrees. Any point on the line is assumed to be 20 degrees.

This procedure is followed until you have drawn a line for each value you want. Usually, isolines are drawn at a fixed range of values, called the *interval*. Here, we will draw lines every 4 degrees. Thus, there will be isotherms for 20, 24, 28, 32, 36 and 40 degrees.

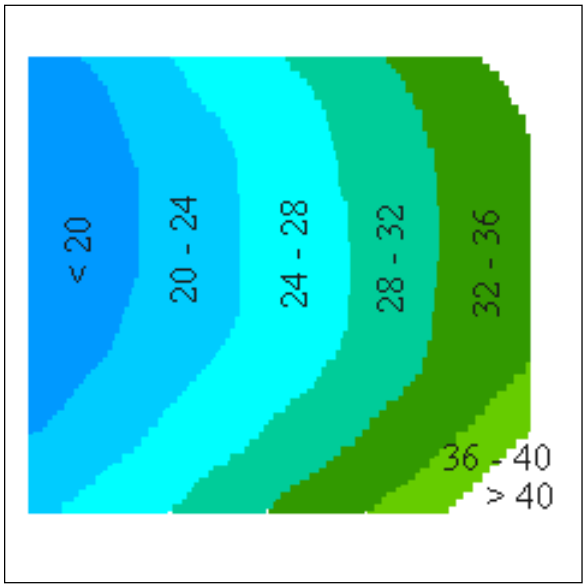


This is the final isotherm map. Since point A lies between the lines representing 24 and 28 degrees, the temperature at point A is between 24 and 28 degrees—or about 26.

Notice that this map looks different from the ones made from your GLOBE student data. Instead of using colors to show the temperatures, we have used labeled lines.

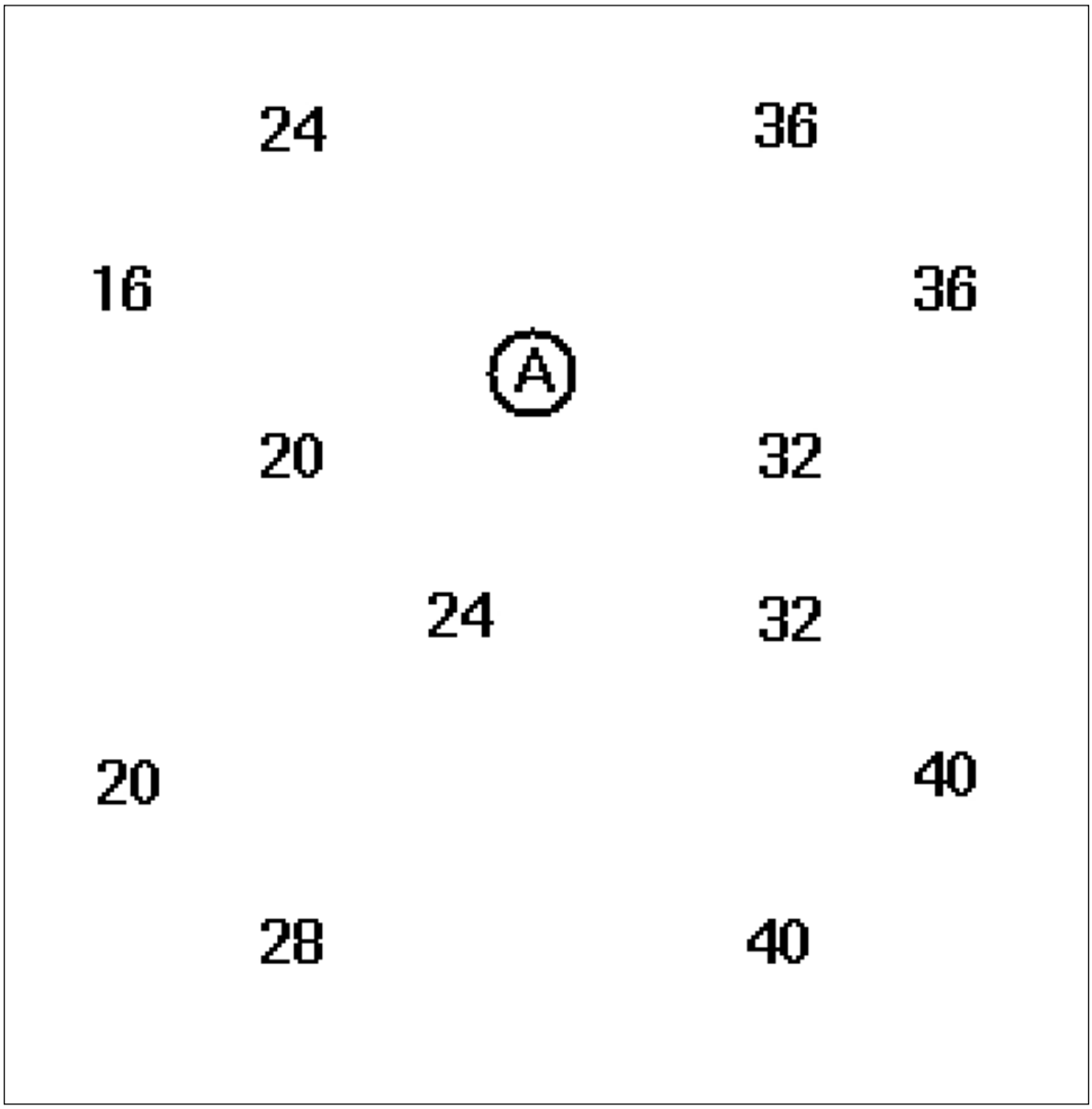


We can make a color isotherm map from this simply by filling in the area between each line with a distinct color, as shown.



Drawing an Isopleth Map

Work Sheet



Title: _____

Interval: _____

A few rules to remember as you create isopleth maps:

1. Isolines never cross each other. Since each line represents a unique value, a point where two lines crossed would have two values. This is not possible! It cannot be both 24 and 28 degrees at the same time.
2. Isolines never end on the map. They either go to the edge of the map or make a circle within the map.
3. Isolines should always be labeled and the interval should be stated on the map.

Note: Isolines can be drawn to connect any type of data displayed on a map. Different types of data are given special names. You have already learned *isotherm,* lines connecting points of equal temperature. Other common terms are:

Isohyets – lines of equal rainfall

Isobars – lines of equal barometric pressure

Contours – lines of equal elevation

Task 2

Create isotherm maps to compare regional variations in temperature to global patterns.

What To Do and How To Do It

1. Examine the global yearly average maximum temperature map. Describe the general pattern of temperature on the map in your Science Log
2. Create an isopleth map from the data map provided for the northeastern USA. Begin at 20 degrees and use an interval of 3 degrees. Does this map seem to follow what you would expect to find on a global scale?
3. Create an isopleth map from the data map provided for Benin. Begin at 32 degrees and use an interval of 2 degrees. Note that isolated values (such as might be found on a mountain top) may have to have their own isoline drawn as a small circle. Does the temperature gradually increase or decrease as you move northward in Benin? What variables might be explored to explain the regional pattern of temperature?
4. Create an isopleth map from the data map provided for Japan and South Korea. Begin at 20 degrees and use an interval of 2 degrees. Note that isolines may increase then decrease on a map, such as when you are going over a mountain. What is the general pattern on this map? What factors might explain differences in the pattern between the global map and your regional map?
5. Create an isopleth map from the data map of Germany and Czech Republic. What type of pattern do you identify? How can you explain this pattern. Hint: compare your map to a contour map.
6. Compare your isopleth maps to the GLOBE visualization maps in the Source Book. Remember that isopleth mapping is based on assumptions of data lines. Examine how your estimations differ from that of the computer generated map.
7. How might more data points change the isopleth lines on your maps?

Middle

LA6: Planning an Investigation

Purpose

To have students plan and carry out an investigation

Student Outcomes

Students will learn to create an hypothesis and to develop a method for accepting or refuting their hypothesis using a small data set.

Overview

Using data from one GLOBE school, students investigate the heat buffering capacity of air, soil and water.

Time

Up to 1 week

Note: This activity may be repeated with other sets of data available on the GLOBE Web site.

Level

Middle: Grades 6 and up

Key Concepts

Explanations involve observations.
Evidence and logic are used to back claims.
Similar steps are used to conduct investigations.
Variables affect outcomes.
Expectations can affect outcomes.
Unexpected findings lead to new investigations.
Clear communication is important in science.

Skills

Organizing data
Recognizing and *describing* patterns
Interpreting graphs
Forming good research questions
Stating a testable hypothesis
Developing a research plan
Using math to analyze a problem
Communicating results

Processes

Scientific method
Student inquiry
Energy cycle

Materials and Tools

GLOBE Science Log
GLOBE Source Book
Calculator or spreadsheet software (not required)

Preparation

Students should be familiar with the steps to research outlined in the preceding Learning Activities: developing a question, stating a hypothesis, creating a methodology, mathematical analysis appropriate for their age level.

Prerequisites

None

Task
Using data from one school, determine if water or soil is a better buffer for heat change.

Preparation

If students are not familiar with the concept of specific heat, a classroom discussion of the relative heating capacities of air, water, and soil may be useful. Have students discuss from their own experiences how long it takes to heat air, relative to soil or water. Does water or soil cool more slowly? Students may need to review Middle Learning Activity 1: *Dancing With Data* for guidance in observations, research questions, and creating an hypothesis. The 'Using GLOBE Data for Student Research and Inquiry' introduction provides guidelines for creating a research project.

Students will need to access the Norfork Elementary (Arkansas, USA) graphs and data for one year from the GLOBE Data Source Book in printed form or from the CD. Data from many other schools may be found online at the GLOBE Web site.

What To Do and How To Do It

1. Examine the data of atmosphere, water, and soil temperatures. Make notes in your Science Log of any interesting patterns, trends or relationships you observe.
2. From your observations, write a well-stated research question about the relationship between air, soil, and water temperature.
3. State a testable hypothesis from your question. Make sure your terms are defined and that you can answer the question, "I will accept (or refute) my hypothesis if…"
4. Outline the method you will use to test the hypothesis:
   a. Which data will you use? Will you use averages?
   b. What variables do you have? Do you need to control any variable?
   c. How will you analyze the data?
   d. How will you present your findings?
5. Complete your research project following the steps you have outlined. Remember, it is acceptable to revise your project outline as you go if needed.
6. Analyze your results and reach a conclusion. Do you accept or refute your hypothesis?
7. Present your findings. What limitations did you have on your research? What further research might be done?